R&S®FSWP-B1
Signal and Spectrum Analyzer
User Manual

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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual describes the following R&S®FSWP models with firmware version 1.10 or higher:

- R&S®FSWP8 (1322.8003K08)
- R&S®FSWP26 (1322.8003K26)

The following options are described:

- R&S FSWP-B1 (1322.9997.08)
- R&S FSWP-B1 (1322.9997.26)

The software contained in this product makes use of several valuable open source software packages. For information, see the "Open Source Acknowledgment" on the user documentation CD-ROM (included in delivery).
Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

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The following abbreviations are used throughout this manual: R&S®FSWP is abbreviated as R&S FSWP. R&S MultiView is abbreviated as MultiView. Products of the R&S®SMW family, e.g. R&S®SMW200A, are abbreviated as R&S SMW.

Basic Safety Instructions

Always read through and comply with the following safety instructions!

All plants and locations of the Rohde & Schwarz group of companies make every effort to keep the safety standards of our products up to date and to offer our customers the highest possible degree of safety. Our products and the auxiliary equipment they require are designed, built and tested in accordance with the safety standards that apply in each case. Compliance with these standards is continuously monitored by our quality assurance system. The product described here has been designed, built and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards. To maintain this condition and to ensure safe operation, you must observe all instructions and warnings provided in this manual. If you have any questions regarding these safety instructions, the Rohde & Schwarz group of companies will be happy to answer them.

Furthermore, it is your responsibility to use the product in an appropriate manner. This product is designed for use solely in industrial and laboratory environments or, if expressly permitted, also in the field and must not be used in any way that may cause personal injury or property damage. You are responsible if the product is used for any purpose other than its designated purpose or in disregard of the manufacturer's instructions. The manufacturer shall assume no responsibility for such use of the product.

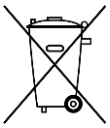
The product is used for its designated purpose if it is used in accordance with its product documentation and within its performance limits (see data sheet, documentation, the following safety instructions). Using the product requires technical skills and, in some cases, a basic knowledge of English. It is therefore essential that only skilled and specialized staff or thoroughly trained personnel with the required skills be allowed to use the product. If personal safety gear is required for using Rohde & Schwarz products, this will be indicated at the appropriate place in the product documentation. Keep the basic safety instructions and the product documentation in a safe place and pass them on to the subsequent users.

Observing the safety instructions will help prevent personal injury or damage of any kind caused by dangerous situations. Therefore, carefully read through and adhere to the following safety instructions before and when using the product. It is also absolutely essential to observe the additional safety instructions on personal safety, for example, that appear in relevant parts of the product documentation. In these safety instructions, the word "product" refers to all merchandise sold and distributed by the Rohde & Schwarz group of companies, including instruments, systems and all accessories. For product-specific information, see the data sheet and the product documentation.

Safety labels on products

The following safety labels are used on products to warn against risks and dangers.

Symbol	Meaning	Symbol	Meaning
	Notice, general danger location Observe product documentation		ON/OFF Power
	Caution when handling heavy equipment		Standby indication
	Danger of electric shock		Direct current (DC)

Symbol	Meaning	Symbol	Meaning
	Caution ! Hot surface		Alternating current (AC)
	Protective conductor terminal To identify any terminal which is intended for connection to an external conductor for protection against electric shock in case of a fault, or the terminal of a protective earth		Direct/alternating current (DC/AC)
	Earth (Ground)		Class II Equipment to identify equipment meeting the safety requirements specified for Class II equipment (device protected by double or reinforced insulation)
	Frame or chassis Ground terminal		EU labeling for batteries and accumulators For additional information, see section "Waste disposal/Environmental protection", item 1.
	Be careful when handling electrostatic sensitive devices		EU labeling for separate collection of electrical and electronic devices For additional information, see section "Waste disposal/Environmental protection", item 2.
	Warning! Laser radiation For additional information, see section "Operation", item 7.		

Signal words and their meaning

The following signal words are used in the product documentation in order to warn the reader about risks and dangers.

DANGER Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE Indicates information considered important, but not hazard-related, e.g. messages relating to property damage.
In the product documentation, the word ATTENTION is used synonymously.

These signal words are in accordance with the standard definition for civil applications in the European Economic Area. Definitions that deviate from the standard definition may also exist in other economic areas or military applications. It is therefore essential to make sure that the signal words described here are always used only in connection with the related product documentation and the related product. The use of signal words in connection with unrelated products or documentation can result in misinterpretation and in personal injury or material damage.

Operating states and operating positions

The product may be operated only under the operating conditions and in the positions specified by the manufacturer, without the product's ventilation being obstructed. If the manufacturer's specifications are not observed, this can result in electric shock, fire and/or serious personal injury or death. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

1. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products: predefined operating position is always with the housing floor facing down, IP protection 2X, use only indoors, max. operating altitude 2000 m above sea level, max. transport altitude 4500 m above sea level. A tolerance of ±10 % shall apply to the nominal voltage and ±5 % to the nominal frequency, overvoltage category 2, pollution degree 2.
2. Do not place the product on surfaces, vehicles, cabinets or tables that for reasons of weight or stability are unsuitable for this purpose. Always follow the manufacturer's installation instructions when installing the product and fastening it to objects or structures (e.g. walls and shelves). An installation that is not carried out as described in the product documentation could result in personal injury or even death.
3. Do not place the product on heat-generating devices such as radiators or fan heaters. The ambient temperature must not exceed the maximum temperature specified in the product documentation or in the data sheet. Product overheating can cause electric shock, fire and/or serious personal injury or even death.

Electrical safety

If the information on electrical safety is not observed either at all or to the extent necessary, electric shock, fire and/or serious personal injury or death may occur.

1. Prior to switching on the product, always ensure that the nominal voltage setting on the product matches the nominal voltage of the mains-supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
2. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with a protective conductor contact and protective conductor.
3. Intentionally breaking the protective conductor either in the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cords or connector strips are implemented, they must be checked on a regular basis to ensure that they are safe to use.
4. If there is no power switch for disconnecting the product from the mains, or if the power switch is not suitable for this purpose, use the plug of the connecting cable to disconnect the product from the mains. In such cases, always ensure that the power plug is easily reachable and accessible at all times. For example, if the power plug is the disconnecting device, the length of the connecting cable must not exceed 3 m. Functional or electronic switches are not suitable for providing disconnection from the AC supply network. If products without power switches are integrated into racks or systems, the disconnecting device must be provided at the system level.
5. Never use the product if the power cable is damaged. Check the power cables on a regular basis to ensure that they are in proper operating condition. By taking appropriate safety measures and carefully laying the power cable, ensure that the cable cannot be damaged and that no one can be hurt by, for example, tripping over the cable or suffering an electric shock.

6. The product may be operated only from TN/TT supply networks fuse-protected with max. 16 A (higher fuse only after consulting with the Rohde & Schwarz group of companies).
7. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket provided for this purpose. Otherwise, sparks that result in fire and/or injuries may occur.
8. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.
9. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures (e.g. appropriate measuring equipment, fuse protection, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
10. Ensure that the connections with information technology equipment, e.g. PCs or other industrial computers, comply with the IEC 60950-1 / EN 60950-1 or IEC 61010-1 / EN 61010-1 standards that apply in each case.
11. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.
12. If a product is to be permanently installed, the connection between the protective conductor terminal on site and the product's protective conductor must be made first before any other connection is made. The product may be installed and connected only by a licensed electrician.
13. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fuse-protected in such a way that anyone who has access to the product, as well as the product itself, is adequately protected from injury or damage.
14. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the person operating the product will be exposed to the danger of an electric shock.
15. Any object that is not designed to be placed in the openings of the housing must not be used for this purpose. Doing so can cause short circuits inside the product and/or electric shocks, fire or injuries.
16. Unless specified otherwise, products are not liquid-proof (see also section "Operating states and operating positions", item 1). Therefore, the equipment must be protected against penetration by liquids. If the necessary precautions are not taken, the user may suffer electric shock or the product itself may be damaged, which can also lead to personal injury.
17. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product has been moved from a cold to a warm environment. Penetration by water increases the risk of electric shock.
18. Prior to cleaning the product, disconnect it completely from the power supply (e.g. AC supply network or battery). Use a soft, non-linting cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluents for cellulose lacquers.

Operation

1. Operating the products requires special training and intense concentration. Make sure that persons who use the products are physically, mentally and emotionally fit enough to do so; otherwise, injuries or material damage may occur. It is the responsibility of the employer/operator to select suitable personnel for operating the products.

2. Before you move or transport the product, read and observe the section titled "Transport".
3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens) such as nickel cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties) when using a Rohde & Schwarz product, consult a physician immediately to determine the cause and to prevent health problems or stress.
4. Before you start processing the product mechanically and/or thermally, or before you take it apart, be sure to read and pay special attention to the section titled "Waste disposal/Environmental protection", item 1.
5. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn babies require increased protection, pregnant women must be protected by appropriate measures. Persons with pacemakers may also be exposed to risks from electromagnetic radiation. The employer/operator must evaluate workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the potential danger.
6. Should a fire occur, the product may release hazardous substances (gases, fluids, etc.) that can cause health problems. Therefore, suitable measures must be taken, e.g. protective masks and protective clothing must be worn.
7. Laser products are given warning labels that are standardized according to their laser class. Lasers can cause biological harm due to the properties of their radiation and due to their extremely concentrated electromagnetic power. If a laser product (e.g. a CD/DVD drive) is integrated into a Rohde & Schwarz product, absolutely no other settings or functions may be used as described in the product documentation. The objective is to prevent personal injury (e.g. due to laser beams).
8. EMC classes (in line with EN 55011/CISPR 11, and analogously with EN 55022/CISPR 22, EN 55032/CISPR 32)
   - Class A equipment:
     Equipment suitable for use in all environments except residential environments and environments that are directly connected to a low-voltage supply network that supplies residential buildings
     Note: Class A equipment is intended for use in an industrial environment. This equipment may cause radio disturbances in residential environments, due to possible conducted as well as radiated disturbances. In this case, the operator may be required to take appropriate measures to eliminate these disturbances.
   - Class B equipment:
     Equipment suitable for use in residential environments and environments that are directly connected to a low-voltage supply network that supplies residential buildings

Repair and service

1. The product may be opened only by authorized, specially trained personnel. Before any work is performed on the product or before the product is opened, it must be disconnected from the AC supply network. Otherwise, personnel will be exposed to the risk of an electric shock.

2. Adjustments, replacement of parts, maintenance and repair may be performed only by electrical experts authorized by Rohde & Schwarz. Only original parts may be used for replacing parts relevant to safety (e.g. power switches, power transformers, fuses). A safety test must always be performed after parts relevant to safety have been replaced (visual inspection, protective conductor test, insulation resistance measurement, leakage current measurement, functional test). This helps ensure the continued safety of the product.

Batteries and rechargeable batteries/cells

If the information regarding batteries and rechargeable batteries/cells is not observed either at all or to the extent necessary, product users may be exposed to the risk of explosions, fire and/or serious personal injury, and, in some cases, death. Batteries and rechargeable batteries with alkaline electrolytes (e.g. lithium cells) must be handled in accordance with the EN 62133 standard.

1. Cells must not be taken apart or crushed.
2. Cells or batteries must not be exposed to heat or fire. Storage in direct sunlight must be avoided. Keep cells and batteries clean and dry. Clean soiled connectors using a dry, clean cloth.
3. Cells or batteries must not be short-circuited. Cells or batteries must not be stored in a box or in a drawer where they can short-circuit each other, or where they can be short-circuited by other conductive materials. Cells and batteries must not be removed from their original packaging until they are ready to be used.
4. Cells and batteries must not be exposed to any mechanical shocks that are stronger than permitted.
5. If a cell develops a leak, the fluid must not be allowed to come into contact with the skin or eyes. If contact occurs, wash the affected area with plenty of water and seek medical aid.
6. Improperly replacing or charging cells or batteries that contain alkaline electrolytes (e.g. lithium cells) can cause explosions. Replace cells or batteries only with the matching Rohde & Schwarz type (see parts list) in order to ensure the safety of the product.
7. Cells and batteries must be recycled and kept separate from residual waste. Rechargeable batteries and normal batteries that contain lead, mercury or cadmium are hazardous waste. Observe the national regulations regarding waste disposal and recycling.

Transport

1. The product may be very heavy. Therefore, the product must be handled with care. In some cases, the user may require a suitable means of lifting or moving the product (e.g. with a lift-truck) to avoid back or other physical injuries.
2. Handles on the products are designed exclusively to enable personnel to transport the product. It is therefore not permissible to use handles to fasten the product to or on transport equipment such as cranes, fork lifts, wagons, etc. The user is responsible for securely fastening the products to or on the means of transport or lifting. Observe the safety regulations of the manufacturer of the means of transport or lifting. Noncompliance can result in personal injury or material damage.
3. If you use the product in a vehicle, it is the sole responsibility of the driver to drive the vehicle safely and properly. The manufacturer assumes no responsibility for accidents or collisions. Never use the product in a moving vehicle if doing so could distract the driver of the vehicle. Adequately secure the product in the vehicle to prevent injuries or other damage in the event of an accident.

Waste disposal/Environmental protection

1. Specially marked equipment has a battery or accumulator that must not be disposed of with unsorted municipal waste, but must be collected separately. It may only be disposed of at a suitable collection point or via a Rohde & Schwarz customer service center.
2. Waste electrical and electronic equipment must not be disposed of with unsorted municipal waste, but must be collected separately.
   Rohde & Schwarz GmbH & Co. KG has developed a disposal concept and takes full responsibility for take-back obligations and disposal obligations for manufacturers within the EU. Contact your Rohde & Schwarz customer service center for environmentally responsible disposal of the product.
3. If products or their components are mechanically and/or thermally processed in a manner that goes beyond their intended use, hazardous substances (heavy-metal dust such as lead, beryllium, nickel) may be released. For this reason, the product may only be disassembled by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.
4. If handling the product releases hazardous substances or fuels that must be disposed of in a special way, e.g. coolants or engine oils that must be replenished regularly, the safety instructions of the manufacturer of the hazardous substances or fuels and the applicable regional waste disposal regulations must be observed. Also observe the relevant safety instructions in the product documentation. The improper disposal of hazardous substances or fuels can cause health problems and lead to environmental damage.

For additional information about environmental protection, visit the Rohde & Schwarz website.

Instrucciones de seguridad elementales

¡Es imprescindible leer y cumplir las siguientes instrucciones e informaciones de seguridad!

El principio del grupo de empresas Rohde & Schwarz consiste en tener nuestros productos siempre al día con los estándares de seguridad y de ofrecer a nuestros clientes el máximo grado de seguridad. Nuestros productos y todos los equipos adicionales son siempre fabricados y examinados según las normas de seguridad vigentes. Nuestro sistema de garantía de calidad controla constantemente que sean cumplidas estas normas. El presente producto ha sido fabricado y examinado según el certificado de conformidad de la UE y ha salido de nuestra planta en estado impecable según los estándares técnicos de seguridad. Para poder preservar este estado y garantizar un funcionamiento libre de peligros, el usuario deberá atenerse a todas las indicaciones, informaciones de seguridad y notas de alerta. El grupo de empresas Rohde & Schwarz está siempre a su disposición en caso de que tengan preguntas referentes a estas informaciones de seguridad.

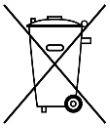
Además queda en la responsabilidad del usuario utilizar el producto en la forma debida. Este producto está destinado exclusivamente al uso en la industria y el laboratorio o, si ha sido expresamente autorizado, para aplicaciones de campo y de ninguna manera deberá ser utilizado de modo que alguna persona/cosa pueda sufrir daño. El uso del producto fuera de sus fines definidos o sin tener en cuenta las instrucciones del fabricante queda en la responsabilidad del usuario. El fabricante no se hace en ninguna forma responsable de consecuencias a causa del mal uso del producto.

Se parte del uso correcto del producto para los fines definidos si el producto es utilizado conforme a las indicaciones de la correspondiente documentación del producto y dentro del margen de rendimiento definido (ver hoja de datos, documentación, informaciones de seguridad que siguen). El uso del producto hace necesarios conocimientos técnicos y ciertos conocimientos del idioma inglés. Por eso se debe tener en cuenta que el producto solo pueda ser operado por personal especializado o personas instruidas en profundidad con las capacidades correspondientes. Si fuera necesaria indumentaria de seguridad para el uso de productos de Rohde & Schwarz, encontraría la información debida en la documentación del producto en el capítulo correspondiente. Guarde bien las informaciones de seguridad elementales, así como la documentación del producto, y entréguelas a usuarios posteriores.

Tener en cuenta las informaciones de seguridad sirve para evitar en lo posible lesiones o daños por peligros de toda clase. Por eso es imprescindible leer detalladamente y comprender por completo las siguientes informaciones de seguridad antes de usar el producto, y respetarlas durante el uso del producto. Deberán tenerse en cuenta todas las demás informaciones de seguridad, como p. ej. las referentes a la protección de personas, que encontrarán en el capítulo correspondiente de la documentación del producto y que también son de obligado cumplimiento. En las presentes informaciones de seguridad se recogen todos los objetos que distribuye el grupo de empresas Rohde & Schwarz bajo la denominación de "producto", entre ellos también aparatos, instalaciones así como toda clase de accesorios. Los datos específicos del producto figuran en la hoja de datos y en la documentación del producto.

Señalización de seguridad de los productos

Las siguientes señales de seguridad se utilizan en los productos para advertir sobre riesgos y peligros.

Símbolo	Significado	Símbolo	Significado
	Aviso: punto de peligro general Observar la documentación del producto		Tensión de alimentación de PUESTA EN MARCHA / PARADA
	Atención en el manejo de dispositivos de peso elevado		Indicación de estado de espera (standby)
	Peligro de choque eléctrico		Corriente continua (DC)
	Advertencia: superficie caliente		Corriente alterna (AC)
	Conexión a conductor de protección		Corriente continua / Corriente alterna (DC/AC)
	Conexión a tierra		El aparato está protegido en su totalidad por un aislamiento doble (reforzado)
	Conexión a masa		Distintivo de la UE para baterías y acumuladores Más información en la sección "Eliminación/protección del medio ambiente", punto 1.

Símbolo	Significado	Símbolo	Significado
	Aviso: Cuidado en el manejo de dispositivos sensibles a la electrostática (ESD)		Distintivo de la UE para la eliminación por separado de dispositivos eléctricos y electrónicos Más información en la sección "Eliminación/protección del medio ambiente", punto 2.
	Advertencia: rayo láser Más información en la sección "Funcionamiento", punto 7.		

Palabras de señal y su significado

En la documentación del producto se utilizan las siguientes palabras de señal con el fin de advertir contra riesgos y peligros.

Indica una situación de peligro que, si no se evita, causa lesiones graves o incluso la muerte.

Indica una situación de peligro que, si no se evita, puede causar lesiones graves o incluso la muerte.

Indica una situación de peligro que, si no se evita, puede causar lesiones leves o moderadas.

Indica información que se considera importante, pero no en relación con situaciones de peligro; p. ej., avisos sobre posibles daños materiales.
En la documentación del producto se emplea de forma sinónima el término CUIDADO.

Las palabras de señal corresponden a la definición habitual para aplicaciones civiles en el área económica europea. Pueden existir definiciones diferentes a esta definición en otras áreas económicas o en aplicaciones militares. Por eso se deberá tener en cuenta que las palabras de señal aquí descritas sean utilizadas siempre solamente en combinación con la correspondiente documentación del producto y solamente en combinación con el producto correspondiente. La utilización de las palabras de señal en combinación con productos o documentaciones que no les correspondan puede llevar a interpretaciones equivocadas y tener por consecuencia daños en personas u objetos.

Estados operativos y posiciones de funcionamiento

El producto solamente debe ser utilizado según lo indicado por el fabricante respecto a los estados operativos y posiciones de funcionamiento sin que se obstruya la ventilación. Si no se siguen las indicaciones del fabricante, pueden producirse choques eléctricos, incendios y/o lesiones graves con posible consecuencia de muerte. En todos los trabajos deberán ser tenidas en cuenta las normas nacionales y locales de seguridad del trabajo y de prevención de accidentes.

1. Si no se convino de otra manera, es para los productos Rohde & Schwarz válido lo que sigue: como posición de funcionamiento se define por principio la posición con el suelo de la caja para abajo, modo de protección IP 2X, uso solamente en estancias interiores, utilización hasta 2000 m sobre el nivel del mar, transporte hasta 4500 m sobre el nivel del mar. Se aplicará una tolerancia de ±10 % sobre el voltaje nominal y de ±5 % sobre la frecuencia nominal. Categoría de sobrecarga eléctrica 2, índice de suciedad 2.
2. No sitúe el producto encima de superficies, vehículos, estantes o mesas, que por sus características de peso o de estabilidad no sean aptos para él. Siga siempre las instrucciones de instalación del fabricante cuando instale y asegure el producto en objetos o estructuras (p. ej. paredes y estantes). Si se realiza la instalación de modo distinto al indicado en la documentación del producto, se pueden causar lesiones o, en determinadas circunstancias, incluso la muerte.
3. No ponga el producto sobre aparatos que generen calor (p. ej. radiadores o calefactores). La temperatura ambiente no debe superar la temperatura máxima especificada en la documentación del producto o en la hoja de datos. En caso de sobrecalentamiento del producto, pueden producirse choques eléctricos, incendios y/o lesiones graves con posible consecuencia de muerte.

Seguridad eléctrica

Si no se siguen (o se siguen de modo insuficiente) las indicaciones del fabricante en cuanto a seguridad eléctrica, pueden producirse choques eléctricos, incendios y/o lesiones graves con posible consecuencia de muerte.

1. Antes de la puesta en marcha del producto se deberá comprobar siempre que la tensión preseleccionada en el producto coincida con la de la red de alimentación eléctrica. Si es necesario modificar el ajuste de tensión, también se deberán cambiar en caso dado los fusibles correspondientes del producto.
2. Los productos de la clase de protección I con alimentación móvil y enchufe individual solamente podrán enchufarse a tomas de corriente con contacto de seguridad y con conductor de protección conectado.
3. Queda prohibida la interrupción intencionada del conductor de protección, tanto en la toma de corriente como en el mismo producto. La interrupción puede tener como consecuencia el riesgo de que el producto sea fuente de choques eléctricos. Si se utilizan cables alargadores o regletas de enchufe, deberá garantizarse la realización de un examen regular de los mismos en cuanto a su estado técnico de seguridad.
4. Si el producto no está equipado con un interruptor para desconectarlo de la red, o bien si el interruptor existente no resulta apropiado para la desconexión de la red, el enchufe del cable de conexión se deberá considerar como un dispositivo de desconexión.
   El dispositivo de desconexión se debe poder alcanzar fácilmente y debe estar siempre bien accesible. Si, p. ej., el enchufe de conexión a la red es el dispositivo de desconexión, la longitud del cable de conexión no debe superar 3 m).
   Los interruptores selectores o electrónicos no son aptos para el corte de la red eléctrica. Si se integran productos sin interruptor en bastidores o instalaciones, se deberá colocar el interruptor en el nivel de la instalación.
5. No utilice nunca el producto si está dañado el cable de conexión a red. Compruebe regularmente el correcto estado de los cables de conexión a red. Asegúrese, mediante las medidas de protección y de instalación adecuadas, de que el cable de conexión a red no pueda ser dañado o de que nadie pueda ser dañado por él, p. ej. al tropezar o por un choque eléctrico.

6. Solamente está permitido el funcionamiento en redes de alimentación TN/TT aseguradas con fusibles de 16 A como máximo (utilización de fusibles de mayor amperaje solo previa consulta con el grupo de empresas Rohde & Schwarz).
7. Nunca conecte el enchufe en tomas de corriente sucias o llenas de polvo. Introduzca el enchufe por completo y fuertemente en la toma de corriente. La no observación de estas medidas puede provocar chispas, fuego y/o lesiones.
8. No sobrecargue las tomas de corriente, los cables alargadores o las regletas de enchufe ya que esto podría causar fuego o choques eléctricos.
9. En las mediciones en circuitos de corriente con una tensión U_{eff} > 30 V se deberán tomar las medidas apropiadas para impedir cualquier peligro (p. ej. medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).
10. Para la conexión con dispositivos informáticos como un PC o un ordenador industrial, debe comprobarse que éstos cumplan los estándares IEC60950-1/EN60950-1 o IEC61010-1/EN 61010-1 válidos en cada caso.
11. A menos que esté permitido expresamente, no retire nunca la tapa ni componentes de la carcasa mientras el producto esté en servicio. Esto pone a descubierto los cables y componentes eléctricos y puede causar lesiones, fuego o daños en el producto.
12. Si un producto se instala en un lugar fijo, se deberá primero conectar el conductor de protección fijo con el conductor de protección del producto antes de hacer cualquier otra conexión. La instalación y la conexión deberán ser efectuadas por un electricista especializado.
13. En el caso de dispositivos fijos que no estén provistos de fusibles, interruptor automático ni otros mecanismos de seguridad similares, el circuito de alimentación debe estar protegido de modo que todas las personas que puedan acceder al producto, así como el producto mismo, estén a salvo de posibles daños.
14. Todo producto debe estar protegido contra sobretensión (debida p. ej. a una caída del rayo) mediante los correspondientes sistemas de protección. Si no, el personal que lo utilice quedará expuesto al peligro de choque eléctrico.
15. No debe introducirse en los orificios de la caja del aparato ningún objeto que no esté destinado a ello. Esto puede producir cortocircuitos en el producto y/o puede causar choques eléctricos, fuego o lesiones.
16. Salvo indicación contraria, los productos no están impermeabilizados (ver también el capítulo "Estados operativos y posiciones de funcionamiento", punto 1). Por eso es necesario tomar las medidas necesarias para evitar la entrada de líquidos. En caso contrario, existe peligro de choque eléctrico para el usuario o de daños en el producto, que también pueden redundar en peligro para las personas.
17. No utilice el producto en condiciones en las que pueda producirse o ya se hayan producido condensaciones sobre el producto o en el interior de éste, como p. ej. al desplazarlo de un lugar frío a otro caliente. La entrada de agua aumenta el riesgo de choque eléctrico.
18. Antes de la limpieza, desconecte por completo el producto de la alimentación de tensión (p. ej. red de alimentación o batería). Realice la limpieza de los aparatos con un paño suave, que no se deshilache. No utilice bajo ningún concepto productos de limpieza químicos como alcohol, acetona o diluyentes para lacas nitrocelulósicas.

Funcionamiento

1. El uso del producto requiere instrucciones especiales y una alta concentración durante el manejo. Debe asegurarse que las personas que manejen el producto estén a la altura de los requerimientos necesarios en cuanto a aptitudes físicas, psíquicas y emocionales, ya que de otra manera no se pueden excluir lesiones o daños de objetos. El empresario u operador es responsable de seleccionar el personal usuario apto para el manejo del producto.
2. Antes de desplazar o transportar el producto, lea y tenga en cuenta el capítulo "Transporte".
3. Como con todo producto de fabricación industrial no puede quedar excluida en general la posibilidad de que se produzcan alergias provocadas por algunos materiales empleados —los llamados alérgenos (p. ej. el níquel)—. Si durante el manejo de productos Rohde & Schwarz se producen reacciones alérgicas, como p. ej. irritaciones cutáneas, estornudos continuos, enrojecimiento de la conjuntiva o dificultades respiratorias, debe avisarse inmediatamente a un médico para investigar las causas y evitar cualquier molestia o daño a la salud.
4. Antes de la manipulación mecánica y/o térmica o el desmontaje del producto, debe tenerse en cuenta imprescindiblemente el capítulo "Eliminación/protección del medio ambiente", punto 1.
5. Ciertos productos, como p. ej. las instalaciones de radiocomunicación RF, pueden a causa de su función natural, emitir una radiación electromagnética aumentada. Deben tomarse todas las medidas necesarias para la protección de las mujeres embarazadas. También las personas con marcapasos pueden correr peligro a causa de la radiación electromagnética. El empresario/operador tiene la obligación de evaluar y señalizar las áreas de trabajo en las que exista un riesgo elevado de exposición a radiaciones.
6. Tenga en cuenta que en caso de incendio pueden desprenderse del producto sustancias tóxicas (gases, líquidos etc.) que pueden generar daños a la salud. Por eso, en caso de incendio deben usarse medidas adecuadas, como p. ej. máscaras antigás e indumentaria de protección.
7. Los productos con láser están provistos de indicaciones de advertencia normalizadas en función de la clase de láser del que se trate. Los rayos láser pueden provocar daños de tipo biológico a causa de las propiedades de su radiación y debido a su concentración extrema de potencia electromagnética. En caso de que un producto Rohde & Schwarz contenga un producto láser (p. ej. un lector de CD/DVD), no debe usarse ninguna otra configuración o función aparte de las descritas en la documentación del producto, a fin de evitar lesiones (p. ej. debidas a irradiación láser).
8. Clases de compatibilidad electromagnética (conforme a EN 55011 / CISPR 11; y en analogía con EN 55022 / CISPR 22, EN 55032 / CISPR 32)
   - Aparato de clase A:
     Aparato adecuado para su uso en todos los entornos excepto en los residenciales y en aquellos conectados directamente a una red de distribución de baja tensión que suministra corriente a edificios residenciales.
     Nota: Los aparatos de clase A están destinados al uso en entornos industriales. Estos aparatos pueden causar perturbaciones radioeléctricas en entornos residenciales debido a posibles perturbaciones guiadas o radiadas. En este caso, se le podrá solicitar al operador que tome las medidas adecuadas para eliminar estas perturbaciones.
   - Aparato de clase B:
     Aparato adecuado para su uso en entornos residenciales, así como en aquellos conectados directamente a una red de distribución de baja tensión que suministra corriente a edificios residenciales.

Reparación y mantenimiento

1. El producto solamente debe ser abierto por personal especializado con autorización para ello. Antes de manipular el producto o abrirlo, es obligatorio desconectarlo de la tensión de alimentación, para evitar toda posibilidad de choque eléctrico.
2. El ajuste, el cambio de partes, el mantenimiento y la reparación deberán ser efectuadas solamente por electricistas autorizados por Rohde & Schwarz. Si se reponen partes con importancia para los aspectos de seguridad (p. ej. el enchufe, los transformadores o los fusibles), solamente podrán ser sustituidos por partes originales. Después de cada cambio de partes relevantes para la seguridad deberá realizarse un control de seguridad (control a primera vista, control del conductor de protección, medición de resistencia de aislamiento, medición de la corriente de fuga, control de funcionamiento). Con esto queda garantizada la seguridad del producto.

Baterías y acumuladores o celdas

Si no se siguen (o se siguen de modo insuficiente) las indicaciones en cuanto a las baterías y acumuladores o celdas, pueden producirse explosiones, incendios y/o lesiones graves con posible consecuencia de muerte. El manejo de baterías y acumuladores con electrolitos alcalinos (p. ej. celdas de litio) debe seguir el estándar EN 62133.

1. No deben desmontarse, abrirse ni triturarse las celdas.
2. Las celdas o baterías no deben someterse a calor ni fuego. Debe evitarse el almacenamiento a la luz directa del sol. Las celdas y baterías deben mantenerse limpias y secas. Limpiar las conexiones sucias con un paño seco y limpio.
3. Las celdas o baterías no deben cortocircuitarse. Es peligroso almacenar las celdas o baterías en estuches o cajones en cuyo interior puedan cortocircuitarse por contacto recíproco o por contacto con otros materiales conductores. No deben extraerse las celdas o baterías de sus embalajes originales hasta el momento en que vayan a utilizarse.
4. Las celdas o baterías no deben someterse a impactos mecánicos fuertes indebidos.
5. En caso de falta de estanqueidad de una celda, el líquido vertido no debe entrar en contacto con la piel ni los ojos. Si se produce contacto, lavar con agua abundante la zona afectada y avisar a un médico.
6. En caso de cambio o recarga inadecuados, las celdas o baterías que contienen electrolitos alcalinos (p. ej. las celdas de litio) pueden explotar. Para garantizar la seguridad del producto, las celdas o baterías solo deben ser sustituidas por el tipo Rohde & Schwarz correspondiente (ver lista de recambios).
7. Las baterías y celdas deben reciclarse y no deben tirarse a la basura doméstica. Las baterías o acumuladores que contienen plomo, mercurio o cadmio deben tratarse como residuos especiales. Respete en esta relación las normas nacionales de eliminación y reciclaje.

Transporte

1. El producto puede tener un peso elevado. Por eso es necesario desplazarlo o transportarlo con precaución y, si es necesario, usando un sistema de elevación adecuado (p. ej. una carretilla elevadora), a fin de evitar lesiones en la espalda u otros daños personales.

2. Las asas instaladas en los productos sirven solamente de ayuda para el transporte del producto por personas. Por eso no está permitido utilizar las asas para la sujeción en o sobre medios de transporte como p. ej. grúas, carretillas elevadoras de horquilla, carros etc. Es responsabilidad suya fijar los productos de manera segura a los medios de transporte o elevación. Para evitar daños personales o daños en el producto, siga las instrucciones de seguridad del fabricante del medio de transporte o elevación utilizado.
3. Si se utiliza el producto dentro de un vehículo, recae de manera exclusiva en el conductor la responsabilidad de conducir el vehículo de manera segura y adecuada. El fabricante no asumirá ninguna responsabilidad por accidentes o colisiones. No utilice nunca el producto dentro de un vehículo en movimiento si esto pudiera distraer al conductor. Asegure el producto dentro del vehículo debidamente para evitar, en caso de un accidente, lesiones u otra clase de daños.

Eliminación/protección del medio ambiente

1. Los dispositivos marcados contienen una batería o un acumulador que no se debe desechar con los residuos domésticos sin clasificar, sino que debe ser recogido por separado. La eliminación se debe efectuar exclusivamente a través de un punto de recogida apropiado o del servicio de atención al cliente de Rohde & Schwarz.
2. Los dispositivos eléctricos usados no se deben desechar con los residuos domésticos sin clasificar, sino que deben ser recogidos por separado.
   Rohde & Schwarz GmbH & Co.KG ha elaborado un concepto de eliminación de residuos y asume plenamente los deberes de recogida y eliminación para los fabricantes dentro de la UE. Para desechar el producto de manera respetuosa con el medio ambiente, diríjase a su servicio de atención al cliente de Rohde & Schwarz.
3. Si se trabaja de manera mecánica y/o térmica cualquier producto o componente más allá del funcionamiento previsto, pueden liberarse sustancias peligrosas (polvos con contenido de metales pesados como p. ej. plomo, berilio o níquel). Por eso el producto solo debe ser desmontado por personal especializado con formación adecuada. Un desmontaje inadecuado puede ocasionar daños para la salud. Se deben tener en cuenta las directivas nacionales referentes a la eliminación de residuos.
4. En caso de que durante el trato del producto se formen sustancias peligrosas o combustibles que deban tratarse como residuos especiales (p. ej. refrigerantes o aceites de motor con intervalos de cambio definidos), deben tenerse en cuenta las indicaciones de seguridad del fabricante de dichas sustancias y las normas regionales de eliminación de residuos. Tenga en cuenta también en caso necesario las indicaciones de seguridad especiales contenidas en la documentación del producto. La eliminación incorrecta de sustancias peligrosas o combustibles puede causar daños a la salud o daños al medio ambiente.

Se puede encontrar más información sobre la protección del medio ambiente en la página web de Rohde & Schwarz.

Quality management and environmental management

Certified Quality System
ISO 9001

Certified Environmental System
ISO 14001

Sehr geehrter Kunde,
Sie haben sich für den Kauf eines Rohde&Schwarz Produktes entschieden. Sie erhalten damit ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unserer Qualitäts- und Umweltmanagementsysteme entwickelt, gefertigt und geprüft. Rohde&Schwarz ist unter anderem nach den Managementsystemen ISO 9001 und ISO 14001 zertifiziert.

Der Umwelt verpflichtet
- Energie-effiziente, RoHS-konforme Produkte
- Kontinuierliche Weiterentwicklung nachhaltiger Umweltkonzepte
- ISO 14001-zertifiziertes Umweltmanagementsystem

Dear customer,
You have decided to buy a Rohde&Schwarz product. This product has been manufactured using the most advanced methods. It was developed, manufactured and tested in compliance with our quality management and environmental management systems. Rohde&Schwarz has been certified, for example, according to the ISO 9001 and ISO 14001 management systems.

Environmental commitment
- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system

Cher client,
Vous avez choisi d'acheter un produit Rohde&Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests de ce produit ont été effectués selon nos systèmes de management de qualité et de management environnemental. La société Rohde&Schwarz a été homologuée, entre autres, conformément aux systèmes de management ISO 9001 et ISO 14001.

Engagement écologique
- Produits à efficience énergétique
- Amélioration continue de la durabilité environnementale
- Système de management environnemental certifié selon ISO 14001

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Customer Support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz equipment, contact one of our Customer Support Centers. A team of highly qualified engineers provides telephone support and will work with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz equipment.

Up-to-date information and upgrades

To keep your instrument up-to-date and to be informed about new application notes related to your instrument, please send an e-mail to the Customer Support Center stating your instrument and your wish. We will take care that you will get the right information.

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Contents

1 Welcome to the R&S FSWP-B1 11

1.1 R&S MultiView 11

2 Measurements 12

2.1 Available Measurement Functions 12

2.2 Basic Measurements 17

2.2.1 How to Perform a Basic Sweep Measurement 17

2.2.2 Measurement Examples - Measuring a Sinusoidal Signal 18

2.2.3 Measurement Example – Measuring Levels at Low S/N Ratios 21

2.2.4 Measurement Examples - Measuring Signal Spectra with Multiple Signals 24

2.2.5 Measurement Examples in Zero Span 31

2.3 Channel Power and Adjacent-Channel Power (ACLR) Measurement 37

2.3.1 About Channel Power Measurements 38

2.3.2 Channel Power Results 38

2.3.3 Channel Power Basics 40

2.3.4 Channel Power Configuration 51

2.3.5 MSR ACLR Configuration 62

2.3.6 How to Perform Channel Power Measurements 77

2.3.7 Measurement Examples 82

2.3.8 Optimizing and Troubleshooting the Measurement 85

2.3.9 Reference: Predefined CP/ACLR Standards 86

2.4 Carrier-to-Noise Measurements 87

2.4.1 About the Measurement 87

2.4.2 Carrier-to-Noise Results 88

2.4.3 Carrier-to-Noise Configuration 89

2.4.4 How to Determine the Carrier-to-Noise Ratio 90

2.5 Occupied Bandwidth Measurement (OBW) 91

2.5.1 About the Measurement 91

2.5.2 OBW Results 93

2.5.3 OBW Configuration 94

2.5.4 How to Determine the Occupied Bandwidth 96

2.5.5 Measurement Example 96

2.6 Spectrum Emission Mask (SEM) Measurement 97
2.6.1 About the Measurement 97
2.6.2 Typical Applications 98
2.6.3 SEM Results 98
2.6.4 SEM Basics 101
2.6.5 SEM Configuration 111
2.6.6 How to Perform a Spectrum Emission Mask Measurement 128
2.6.7 Measurement Example: Multi-SEM Measurement 133
2.6.8 Reference: SEM File Descriptions 134
2.7 Spurious Emissions Measurement 141
2.7.1 About the Measurement 141
2.7.2 Spurious Emissions Measurement Results 142
2.7.3 Spurious Emissions Basics 143
2.7.4 Spurious Emissions Measurement Configuration 145
2.7.5 How to Perform a Spurious Emissions Measurement 151
2.7.6 Reference: ASCII Export File Format (Spurious) 152
2.8 Statistical Measurements (APD, CCDF) 154
2.8.1 About the Measurements 154
2.8.2 Typical Applications 155
2.8.3 APD and CCDF Results 155
2.8.4 APD and CCDF Basics - Gated Triggering 158
2.8.5 APD and CCDF Configuration 159
2.8.6 How to Perform an APD or CCDF Measurement 165
2.8.7 Examples 166
2.8.8 Optimizing and Troubleshooting the Measurement 169
2.9 Time Domain Power Measurement 169
2.9.1 About the Measurement 169
2.9.2 Time Domain Power Results 169
2.9.3 Time Domain Power Basics - Range Definition Using Limit Lines 170
2.9.4 Time Domain Power Configuration 171
2.9.5 How to Measure Powers in the Time Domain 172
2.9.6 Measurement Example 172
2.10 Harmonic Distortion Measurement 173

2.10.1 About the Measurement....174
2.10.2 Harmonic Distortion Basics....174
2.10.3 Harmonic Distortion Results....177
2.10.4 Harmonic Distortion Configuration....177
2.10.5 How to Determine the Harmonic Distortion....179
2.11 Third Order Intercept (TOI) Measurement....179
2.11.1 About the TOI Measurement....180
2.11.2 TOI Basics....180
2.11.3 TOI Results....184
2.11.4 TOI Configuration....185
2.11.5 How to Determine the Third Order Intercept....186
2.11.6 Measurement Example – Measuring the R&S FSWP's Intrinsic Intermodulation....187
2.12 AM Modulation Depth Measurement....189
2.12.1 About the Measurement....189
2.12.2 AM Modulation Depth Results....189
2.12.3 AM Modulation Depth Configuration....190
2.12.4 Optimizing and Troubleshooting the Measurement....191
2.12.5 How to Determine the AM Modulation Depth....192
3 Common Measurement Settings....193
3.1 Configuration Overview....193
3.2 Data Input and Output....194
3.2.1 Receiving Data Input and Providing Data Output....195
3.2.2 Input Source Settings....197
3.2.3 Power Sensors....198
3.2.4 Optional External Generator Control....207
3.2.5 Output Settings....234
3.3 Frequency and Span Configuration....238
3.3.1 Impact of the Frequency and Span Settings....238
3.3.2 Frequency and Span Settings....240
3.3.3 How To Define the Frequency Range....245
3.3.4 How to Move the Center Frequency through the Frequency Range....246
3.3.5 How to Keep the Center Frequency Stable....246
3.4 Amplitude and Vertical Axis Configuration....246

3.4.1 Impact of the Vertical Axis Settings....247
3.4.2 Amplitude Settings....249
3.4.3 Scaling the Y-Axis....253
3.4.4 How to Optimize the Amplitude Display....254
3.5 Bandwidth, Filter and Sweep Configuration....255
3.5.1 Impact of the Bandwidth, Filter and Sweep Settings....255
3.5.2 Bandwidth, Filter and Sweep Settings....261
3.5.3 Reference: List of Available RRC and Channel Filters....269
3.6 Trigger and Gate Configuration....271
3.6.1 Basics of Triggering and Gated Measurements....271
3.6.2 Trigger and Gate Settings....277
3.6.3 How to Configure a Triggered and Gated Measurement....285
3.6.4 How to Output a Trigger Signal....288
3.7 Adjusting Settings Automatically....288
3.8 Transducer....291
3.8.1 Basics on Transducer Factors....291
3.8.2 Transducer Settings....292
3.8.3 How to Configure the Transducer....297
4 Common Analysis and Display Functions....301
4.1 Result Display Configuration....301
4.1.1 Basic Evaluation Methods....301
4.1.2 Laying out the Result Display with the SmartGrid....304
4.2 Zoomed Displays....308
4.2.1 Single Zoom Versus Multiple Zoom....308
4.2.2 Zoom Functions....310
4.2.3 How to Zoom Into a Diagram....311
4.3 Configuring Traces....313
4.3.1 Basic Information about Traces....313
4.3.2 Trace Configuration....326
4.3.3 How to Configure a Standard Trace....337
4.3.4 How to Export Trace Data and Numerical Results....338
4.3.5 How to Display and Configure a Spectrogram....339
4.3.6 Reference: ASCII File Export Format....343

4.3.7 Formats for Returned Values: ASCII Format and Binary Format....347
4.4 Marker Usage....347
4.4.1 Basics on Markers and Marker Functions....348
4.4.2 Marker Settings....358
4.4.3 Marker Search Settings and Positioning Functions....363
4.4.4 Marker Function Configuration....369
4.4.5 How to Work With Markers....378
4.4.6 Measurement Example: Measuring Harmonics Using Marker Functions....380
4.5 Display and Limit Lines....381
4.5.1 Basics on Display Lines....382
4.5.2 Basics on Limit Lines....382
4.5.3 Settings and Functions for Display and Limit Lines....386
4.5.4 How to Work with Display and Limit Lines....392
5 Remote Control Commands for the Spectrum Application....397
5.1 Introduction....397
5.1.1 Conventions used in Descriptions....397
5.1.2 Long and Short Form....398
5.1.3 Numeric Suffixes....398
5.1.4 Optional Keywords....399
5.1.5 Alternative Keywords....399
5.1.6 SCPI Parameters....399
5.2 Configuring and Performing Measurements....402
5.2.1 Performing Measurements....402
5.2.2 Performing a Sequence of Measurements....405
5.2.3 Configuring Power Measurements....407
5.2.4 Measuring the Channel Power and ACLR....412
5.2.5 Measuring the Carrier-to-Noise Ratio....447
5.2.6 Measuring the Occupied Bandwidth....448
5.2.7 Measuring with Spectrum Emission Masks....450
5.2.8 Measuring Spurious Emissions....484
5.2.9 Analyzing Statistics....497
5.2.10 Measuring the Time Domain Power....506
5.2.11 Measuring the Harmonic Distortion....514

5.2.12 Measuring the Third Order Intercept Point....517
5.2.13 Measuring the AM Modulation Depth....519
5.2.14 List Evaluations....521
5.2.15 Measuring the Pulse Power....525
5.2.16 Programming Example: Performing a Basic Frequency Sweep....530
5.3 Remote Commands to Select the Spectrum Application....532
5.4 General Window Commands....536
5.5 Working with Windows in the Display....537
5.6 Preset....543
5.7 Common Measurement Settings....544
5.7.1 Configuring Inputs and Ouputs....544
5.7.2 Defining the Frequency....569
5.7.3 Amplitude Settings....575
5.7.4 Scaling the Y-Axis....578
5.7.5 Remote Commands to Define Filter Characteristics....580
5.7.6 Remote Commands to Control a Measurement....583
5.7.7 Trigger Configuration....589
5.7.8 Automatic Configuration....596
5.7.9 Transducer....599
5.8 Common Analysis and Display Functions....603
5.8.1 Zoom....603
5.8.2 Remote Commands to Configure Traces....605
5.8.3 Marker Usage....622
5.8.4 Lines....660
6 Maintenance....673
7 Optimizing and Troubleshooting....674
7.1 Error Information....674
7.2 Error Messages in Remote Control Mode....675
7.3 Troubleshooting Remote Operation....676
7.4 Minimizing the Measurement Duration....678
7.5 Improving Averaging Results....678
7.6 Miscellaneous Troubleshooting Hints....678
7.7 Obtaining Technical Support....679

List of Commands.....681

Index.....695

1 Welcome to the R&S FSWP-B1

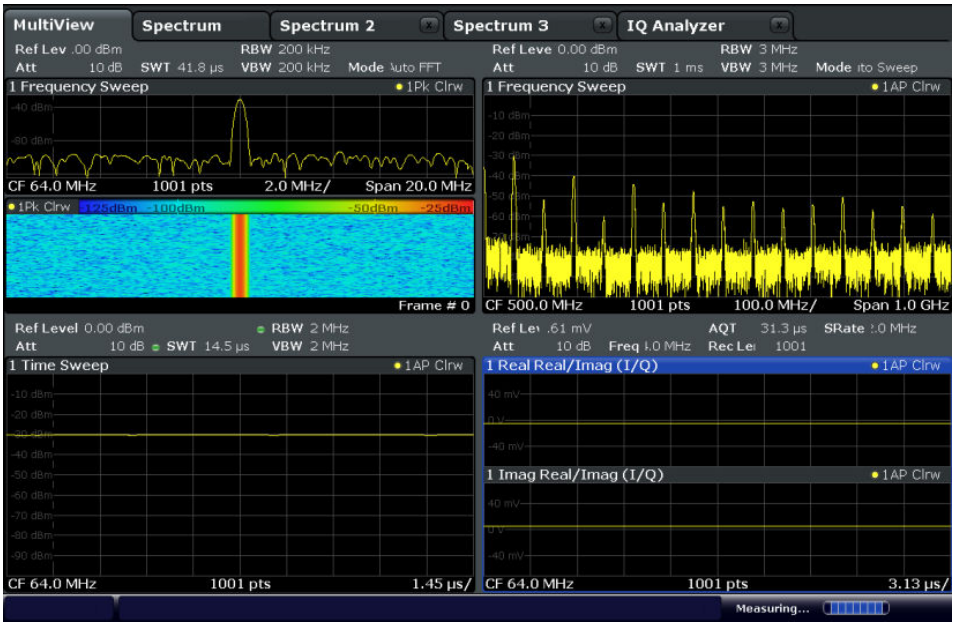
The R&S FSWP-B1 Signal and Spectrum Analyzer is a hardware option that adds the functionality of a conventional signal and spectrum analyzer to your R&S FSWP.

Depending on the R&S FSWP model you have (8 GHz or 26 GHz), you have to equip the R&S FSWP with the corresponding spectrum analyzer option: 1322.9997.08 for 8 GHz models or 1322.9997.26 for 26 GHz models.

This user manual contains a description of the functionality of the Spectrum application, including remote control operation. The latest version is available for download at the product homepage (http://www2.rohde-schwarz.com/product/FSWP.html).

1.1 R&S MultiView

Each application is displayed in a separate tab. An additional tab ("MultiView") provides an overview of all currently active channels at a glance. In the "MultiView" tab, each individual window contains its own channel bar with an additional button. Select this button to switch to the corresponding channel display quickly.



Remote command:

`DISPlay:FORMat` on page 536

2 Measurements

In the Spectrum application, the R&S FSWP provides a variety of different measurement functions.

- **Basic measurements** - measure the spectrum of your signal or watch your signal in time domain
- **Power measurements** - calculate the powers involved in modulated carrier signals
- **Emission measurements** - detect unwanted signal emission
- **Statistic measurements** - evaluate the spectral distribution of the signal
- **Special measurements** - provide characteristic values of the signal

The individual functions are described in detail in the following chapters.

Measurements on I/Q-based data

The I/Q Analyzer application (*not Master*) **in MSRA mode** can also perform measurements on the captured I/Q data in the time and frequency domain.

The measurements are configured using the same settings as described here for the Spectrum application.

The results, however, may differ slightly as hardware settings are not adapted automatically as for the Spectrum application. Additionally, the analysis interval used for the measurement is indicated as in all MSRA applications.

For more information see the R&S FSWP MSRA User Manual.

- Available Measurement Functions....12
- Basic Measurements....17
- Channel Power and Adjacent-Channel Power (ACLR) Measurement....37
- Carrier-to-Noise Measurements....87
- Occupied Bandwidth Measurement (OBW)....91
- Spectrum Emission Mask (SEM) Measurement....97
- Spurious Emissions Measurement....141
- Statistical Measurements (APD, CCDF)....154
- Time Domain Power Measurement....169
- Harmonic Distortion Measurement....173
- Third Order Intercept (TOI) Measurement....179
- AM Modulation Depth Measurement....189

2.1 Available Measurement Functions

The measurement function determines which settings, functions and evaluation methods are available in the R&S FSWP. The various measurement functions are described in detail here. They are selected in the "Select Measurement" dialog box that is displayed when you press the MEAS key or select "Select Measurement" in the configuration "Overview".

When you select a measurement function, the measurement is started with its default settings immediately and the corresponding measurement configuration menu is displayed. The measurement configuration menu can be displayed at any time by pressing the MEAS CONFIG key.

The easiest way to configure measurements is using the configuration "Overview", see chapter 3.1, "Configuration Overview", on page 193.

In addition to the measurement-specific parameters, the general parameters can be configured as usual, see chapter 3, "Common Measurement Settings", on page 193. Many measurement functions provide special result displays or evaluation methods; however, in most cases the general evaluation methods are also available, see chapter 4, "Common Analysis and Display Functions", on page 301.

Frequency Sweep 13
Zero Span 13
Ch Power ACLR 14
C/N, C/No 14
OBW 14
Spectrum Emission Mask 15
Spurious Emissions 15
APD 15
CCDF 16
Time Domain Power 16
TOI 16
AM Mod Depth 16
Harmonic Distortion 16
Marker Functions 17
All Functions Off 17

Frequency Sweep
A common frequency sweep of the input signal over a specified span. Can be used for general purposes to obtain basic measurement results such as peak levels and spectrum traces. The "Frequency" menu is displayed. This is the default measurement if no other function is selected.

Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see chapter 3, "Common Measurement Settings", on page 193).

Remote command:
`[SENSe:]FREQuency:STARt` on page 572, `[SENSe:]FREQuency:STOP` on page 573
`INITiate<n>[:IMMediate]` on page 403
`INITiate<n>:CONTinuous` on page 404

Zero Span
A sweep in the time domain at the specified (center) frequency, i.e. the frequency span is set to zero. The display shows the time on the x-axis and the signal level on the y-axis, as on an oscilloscope. On the time axis, the grid lines correspond to 1/10 of the current sweep time.

Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see chapter 3, "Common Measurement Settings", on page 193).

Most result evaluations can also be used for zero span measurements, although some functions (e.g. markers) may work slightly differently and some may not be available. If so, this will be indicated in the function descriptions (see chapter 4, "Common Analysis and Display Functions", on page 301).

Remote command:
`[SENSe:]FREQuency:SPAN` on page 572
`INITiate<n>[:IMMediate]` on page 403
`INITiate<n>:CONTinuous` on page 404

Ch Power ACLR
Measures the active channel or adjacent-channel power for one or more carrier signals, depending on the current measurement configuration, and opens a submenu to configure the channel power measurement.

For details see chapter 2.3, "Channel Power and Adjacent-Channel Power (ACLR) Measurement", on page 37.

Remote command:
`CALC:MARK:FUNC:POW:SEL ACP`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` on page 410
Results:
`CALC:MARK:FUNC:POW:RES? ACP`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?` on page 408
All commands: chapter 5.2.4, "Measuring the Channel Power and ACLR", on page 412

C/N, C/No
Measures the carrier/noise ratio and opens a submenu to configure the measurement. Measurements without (C/N) and measurements with reference to the bandwidth (C/No) are possible.

Carrier/noise measurement is only possible in the frequency domain (span > 0).

For details see chapter 2.4, "Carrier-to-Noise Measurements", on page 87.

Remote command:
`CALC:MARK:FUNC:POW:SEL CN | CN0``CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` on page 410
Results:
`CALC:MARK:FUNC:POW:RES? CN | CN0`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?` on page 408
All commands: chapter 5.2.5, "Measuring the Carrier-to-Noise Ratio", on page 447

OBW
Measures the occupied bandwidth, i.e. the bandwidth which must contain a defined percentage of the power, and opens a submenu to configure the measurement. For details see chapter 2.5, "Occupied Bandwidth Measurement (OBW)", on page 91.

OBW measurement is only possible in the frequency domain (span > 0).

Remote command:
CALC:MARK:FUNC:POW:SEL OBWCALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect on page 410
Results:
CALC:MARK:FUNC:POW:RES? OBW, see CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult? on page 408
All commands: chapter 5.2.6, "Measuring the Occupied Bandwidth", on page 448

Spectrum Emission Mask
Activates a Spectrum Emission Mask (SEM) measurement, which monitors compliance with a spectral mask, and opens a submenu to configure the measurement.

For details see chapter 2.6, "Spectrum Emission Mask (SEM) Measurement", on page 97.

Remote command:
SENS:SWE:MODE ESP, see [SENSe:]SWEep:MODE on page 452
Results:
CALC:MARK:FUNC:POW:RES? CPOW | PPOW, see CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult? on page 408
CALC:LIM:FAIL?, see CALCulate<n>:LIMit<k>:FAIL? on page 665
TRACe<n>[:DATA] on page 606
TRACe<n>[:DATA]:X? on page 608
All commands: chapter 5.2.7, "Measuring with Spectrum Emission Masks", on page 450

Spurious Emissions
Activates the Spurious Emissions measurement, which monitors unwanted RF products outside the assigned frequency band generated by an amplifier. A submenu to configure the measurement is opened.

For details see chapter 2.7, "Spurious Emissions Measurement", on page 141.

Remote command:
SENS:SWE:MODE LIST, see [SENSe:]SWEep:MODE on page 452
Results:
TRAC:DATA? SPUR, see TRACe<n>[:DATA] on page 606
All commands: chapter 5.2.8, "Measuring Spurious Emissions", on page 484

APD
Measures the amplitude probability density (APD) and opens a submenu to configure the measurement.

For details see chapter 2.8, "Statistical Measurements (APD, CCDF)", on page 154.

Remote command:
CALCulate<n>:STATistics:APD[:STATe] on page 497
Results:
CALCulate<n>:STATistics:RESult<t>? on page 504

CCDF
Measures the complementary cumulative distribution function (CCDF) and opens a submenu to configure the measurement.

For details see chapter 2.8, "Statistical Measurements (APD, CCDF)", on page 154.

Remote command:
`CALCulate<n>:STATistics:CCDF[:STATe]` on page 497
Results:
`CALCulate<n>:STATistics:CCDF:X<t>?` on page 503
`CALCulate<n>:STATistics:RESult<t>?` on page 504

Time Domain Power
Measures the power in zero span and opens a submenu to configure the measurement. For details see chapter 2.2, "Basic Measurements", on page 17.

A time domain power measurement is only possible for zero span.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary[:STATe]` on page 507
All commands: chapter 5.2.10, "Measuring the Time Domain Power", on page 506

TOI
Measures the third order intercept point and opens a submenu to configure the measurement.

For details see chapter 2.11, "Third Order Intercept (TOI) Measurement", on page 179.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:TOI[:STATe]` on page 518
`CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult?` on page 517
All commands: chapter 5.2.12, "Measuring the Third Order Intercept Point", on page 517

AM Mod Depth
Measures the AM modulation depth and opens a submenu to configure the measurement. An AM-modulated carrier is required in the window to ensure correct operation.

For details see chapter 2.12, "AM Modulation Depth Measurement", on page 189.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:MDEPth[:STATe]` on page 520
`CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:RESult?` on page 519
All commands: chapter 5.2.12, "Measuring the Third Order Intercept Point", on page 517

Harmonic Distortion
Measures the harmonic distortion, including the total harmonic distortion, and opens a submenu to configure the measurement.

For details see chapter 2.10, "Harmonic Distortion Measurement", on page 173.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:HARMonics[:STATe]` on page 514
First harmonic: `CALCulate<n>:MARKer<m>:FUNCtion:CENTer` on page 573.
THD: `CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:DISTortion?` on page 516
List of harmonics: `CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:LIST?` on page 516
All commands: chapter 5.2.13, "Measuring the AM Modulation Depth", on page 519

Marker Functions
In addition to the measurement functions, some special marker functions are available. See chapter 4.4.4, "Marker Function Configuration", on page 369.

All Functions Off
Switches off all measurement functions and returns to a basic frequency sweep.

2.2 Basic Measurements

Basic measurements are common sweeps in the time or frequency domain which provide an overview of the basic input signal characteristics.

If no other measurement function is selected, or if all measurement functions are switched off, the R&S FSWP performs a basic frequency or time sweep.

Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see chapter 3, "Common Measurement Settings", on page 193).

2.2.1 How to Perform a Basic Sweep Measurement

To perform one or more single sweeps

1. Configure the frequency and span to be measured ("Frequency" dialog box, see chapter 3.3, "Frequency and Span Configuration", on page 238).
2. Configure the number of sweeps to be performed in a single measurement ("Sweep Config" dialog box, see "Sweep / Average Count" on page 265).
3. If necessary, configure how the signal is processed internally ("Bandwidth" dialog box, see "Sweep Type" on page 266).
4. If necessary, configure a trigger for the measurement ("Trigger/Gate Settings" dialog box, see chapter 3.6, "Trigger and Gate Configuration", on page 271).
5. Define how the results are evaluated for display ("Trace" dialog box, see chapter 4.3.2.1, "Trace Settings", on page 326).

6. If necessary, configure the vertical axis of the display ("Amplitude" dialog box, see chapter 3.4.3, "Scaling the Y-Axis", on page 253).
7. To start the measurement, select one of the following:
   - RUN SINGLE key
   - "Single Sweep" softkey in the "Sweep" menu

   The defined number of sweeps are performed, then the measurement is stopped. While the measurement is running, the RUN SINGLE key is highlighted. To abort the measurement, press the RUN SINGLE key again. The key is no longer highlighted. The results are not deleted until a new measurement is started.
8. To repeat the same number of sweeps without deleting the last trace, select the "Continue Single Sweep" softkey in the "Sweep" menu.

To start continuous sweeping

1. If you want to average the trace or search for a maximum over more (or less) than 10 sweeps, configure the "Average/Sweep Count" ("Sweep Config" dialog box, see "Sweep / Average Count" on page 265).
2. To start the measurement, select one of the following:
   - RUN CONT key
   - "Continuous Sweep" softkey in the "Sweep" menu

   After each sweep is completed, a new one is started automatically. While the measurement is running, the RUN CONT key is highlighted. To stop the measurement, press the RUN CONT key again. The key is no longer highlighted. The results are not deleted until a new measurement is started.

2.2.2 Measurement Examples - Measuring a Sinusoidal Signal

One of the most common measurement tasks that can be handled using a signal analyzer is determining the level and frequency of a signal. When measuring an unknown signal, you can usually start with the presettings.

NOTICE

High input values

If levels higher than +30 dBm (=1 W) are expected or are possible, a power attenuator must be inserted before the RF input of the analyzer. Otherwise, signal levels exceeding 30 dBm can damage the RF attenuator or the input mixer. The total power of all occurring signals must be taken into account.

Test setup

- Connect the RF output of the signal generator to the RF input of the R&S FSWP.

Table 2-1: Signal generator settings (e.g. R&S SMW)

Frequency	128 MHz
Level	-30 dBm

- Measuring the Level and Frequency Using Markers.....19
- Measuring the Signal Frequency Using the Signal Counter..... 20

2.2.2.1 Measuring the Level and Frequency Using Markers

The level and frequency of a sinusoidal signal can be measured easily using the marker function. The R&S FSWP always displays its amplitude and frequency at the marker position. The frequency measurement uncertainty is determined by the reference frequency of the R&S FSWP, the resolution of the marker frequency display and the number of sweep points.

1. Select PRESET to reset the instrument.
2. Enter the Spectrum application via the MODE key.
3. Connect the signal to be measured to the RF INPUT connector on the R&S FSWP.
4. Set the center frequency to *128 MHz*.
5. Reduce the frequency span to *1 MHz*.

   Note: Coupled settings. When the frequency span is defined, the resolution bandwidth, the video bandwidth and the sweep time are automatically adjusted, because these functions are defined as coupled functions in the presettings.
6. Select MKR to activate marker 1 and automatically set it to the maximum of the trace.

   The level and frequency values measured by the marker are displayed in the marker information at the top of the display.

   Note: Performing a peak search. When a marker is initially activated, it automatically performs the peak search function (as shown in the example).
   If a marker was already active, select the PEAK SEARCH key or the "Peak" softkey in the MKR > menu in order to set the currently active marker to the maximum of the displayed signal.

Increasing the Frequency Resolution

The frequency resolution of the marker is determined by the resolution of the trace. A trace consists of 1001 trace points, i.e. if the frequency span is 1 MHz, each trace point represents a span of approximately 1 kHz. This corresponds to a maximum uncertainty of +/- 0.5 kHz.

You can increase the resolution of the trace by reducing the frequency span.

Reducing the frequency span to 10 kHz

► Reduce the frequency span to *10 kHz*.

The resolution of the trace is now approximately 10 Hz (10 kHz span / 1001 trace points), thus, the precision of the marker frequency display increases to approximately ±5 Hz.

Setting the Reference Level

The reference level is the level at the upper limit of the diagram. To achieve the widest dynamic range possible for a spectrum measurement, use the entire level span of the R&S FSWP. In other words, the highest level that occurs in the signal should be located at the top edge of the diagram (= reference level) or immediately below it.

Low Reference Levels

If the selected reference level is lower than the highest signal that occurs in the spectrum, the signal path in the R&S FSWP is overloaded.

In this case, the message "IFOVL" is displayed in the error message field.

In the presettings, the value of the reference level is 0 dBm. If the input signal is -30 dBm, the reference level can be reduced by 30 dB without causing the signal path to be overloaded.

Reducing the reference level by 30 dB

► Set the reference level to *-30 dBm*.

The maximum of the trace is near the maximum of the measurement diagram. The increase in the displayed noise is not substantial. Thus, the distance between the signal maximum and the noise display (=dynamic range) has increased.

Setting the reference level with the help of a marker

You can also use a marker to shift the maximum value of the trace directly to the top edge of the diagram. If the marker is located at the maximum level of the trace (as in this example), the reference level can be moved to the marker level as follows:

1. Press the MKR -> key.
2. Select "Ref Lvl = Mkr Lvl".

   The reference level is set to the current marker level.

2.2.2.2 Measuring the Signal Frequency Using the Signal Counter

The built-in signal counter allows you to measure the frequency more accurately than measuring it with the marker. The frequency sweep is stopped at the marker, and the R&S FSWP measures the frequency of the signal at the marker position (see also chapter 4.4.1.5, "Performing a Highly Accurate Frequency Measurement (Signal Count)", on page 353).

In the following example, the frequency of the generator at 128 MHz is shown using the marker.

Prerequisite

Precise frequency measurements require a precise reference frequency. Therefore, an external reference frequency from the signal generator is used. Connect the signal generator's "Ref OUT" connector to the analyzer's "Ref IN" connector.

1. Select PRESET to reset the instrument.
2. Enter the Spectrum application via the MODE key.
3. Set the center frequency to *128 MHz*.
4. Set the frequency span to *1 MHz*.
5. Select "Setup" > "Reference" > "External Reference 10 MHz" to activate the external reference frequency.
6. Select MKR to activate marker 1 and automatically set it to the maximum of the trace.

   The level and the frequency of the marker are displayed in the marker results in the diagram or the marker table.
7. Select MKR FUNC > "Signal Count" to activate the signal counter.

   The result of the signal counter is displayed in the marker results.
8. If necessary, increase the resolution of the signal counter by selecting "Signal Count Resolution" (in the "Signal Count" menu).

Prerequisites for using the internal signal counter

In order to obtain a correct result when measuring the frequency with the internal signal counter, an RF sinusoidal signal or a spectral line must be available. The marker must be located more than 25 dB above the noise level to ensure that the specified measurement accuracy is adhered to.

2.2.3 Measurement Example – Measuring Levels at Low S/N Ratios

The minimum signal level a signal analyzer can measure is limited by its intrinsic noise. Small signals can be swamped by noise and therefore cannot be measured. For signals that are just above the intrinsic noise, the accuracy of the level measurement is influenced by the intrinsic noise of the R&S FSWP.

The displayed noise level of a signal analyzer depends on its noise figure, the selected RF attenuation, the selected reference level, the selected resolution and video bandwidth and the detector.

For details see:

- chapter 3.4.1.2, "RF Attenuation", on page 248

- chapter 3.4.1.1, "Reference Level", on page 247
- chapter 3.5.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth", on page 256
- chapter 3.5.1.2, "Smoothing the Trace Using the Video Bandwidth", on page 256
- chapter 4.3.1.1, "Mapping Samples to measurement Points with the Trace Detector", on page 313

This measurement example shows the different factors influencing the S/N ratio.

Table 2-2: Signal generator settings (e.g. R&S SMW)

Frequency	128 MHz
Level	-95 dBm

1. Preset the R&S FSWP.
2. Enter the Spectrum application via the MODE key.
3. Set the center frequency to *128 MHz*.
4. Set the span to *100 MHz*.
5. Set the reference level to-*30 dBm*.

   The signal is measured with the auto peak detector and is completely hidden in the intrinsic noise of the R&S FSWP.

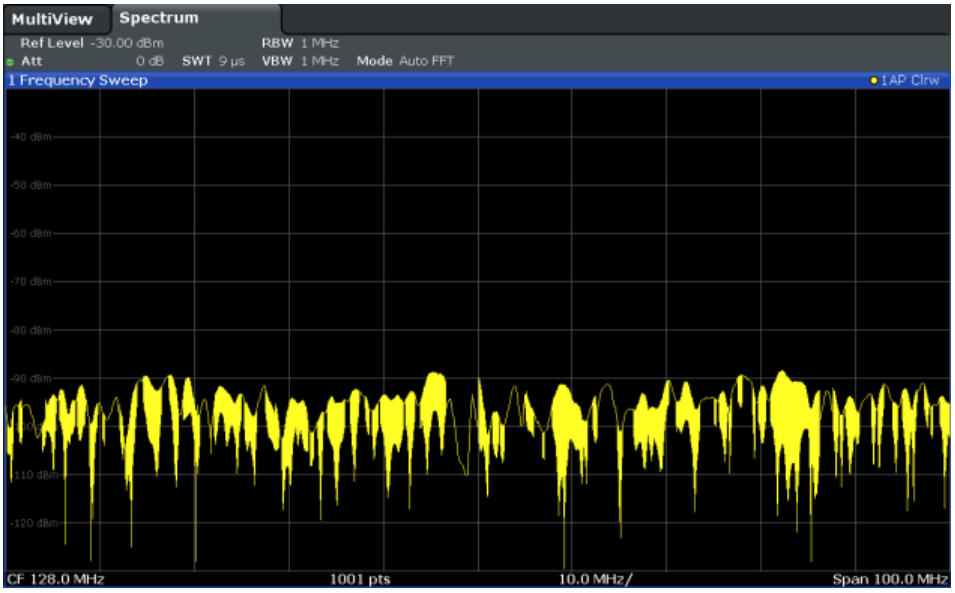


Fig. 2-1: Sine wave signal with low S/N ratio

6. To suppress noise spikes, average the trace. In the "Traces" configuration dialog, set the "Trace mode" to "Average" (see "Trace Mode" on page 327).

   The traces of consecutive sweeps are averaged. To perform averaging, the R&S FSWP automatically switches on the sample detector. The RF signal, therefore, can be more clearly distinguished from noise.

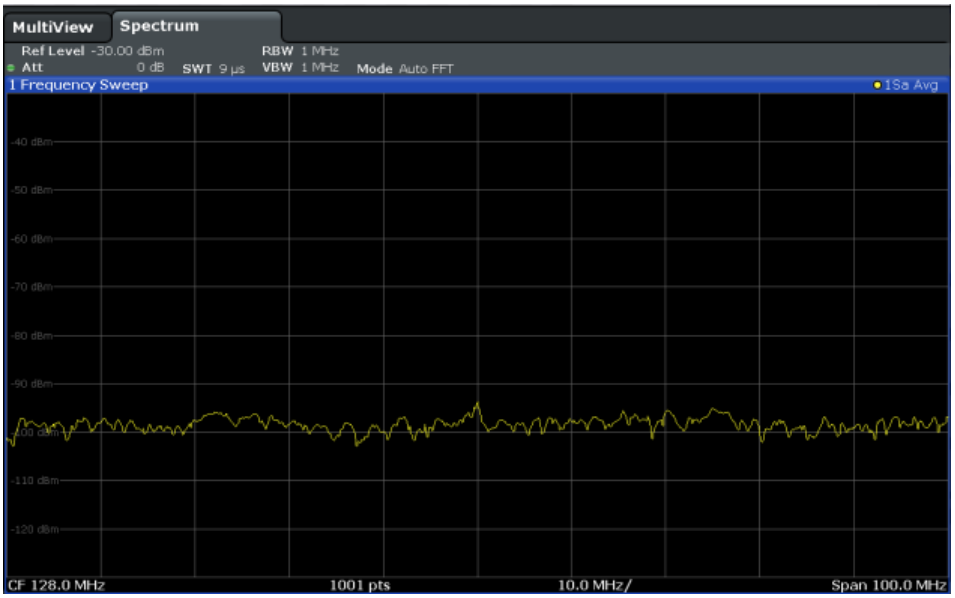


Fig. 2-2: RF sine wave signal with low S/N ratio with an averaged trace

7. Instead of trace averaging, you can select a video filter that is narrower than the resolution bandwidth. Set the trace mode back to "Clear Write", then set the VBW to *10 kHz* manually in the "Bandwidth" configuration dialog.

   The RF signal can be distinguished from noise more clearly.

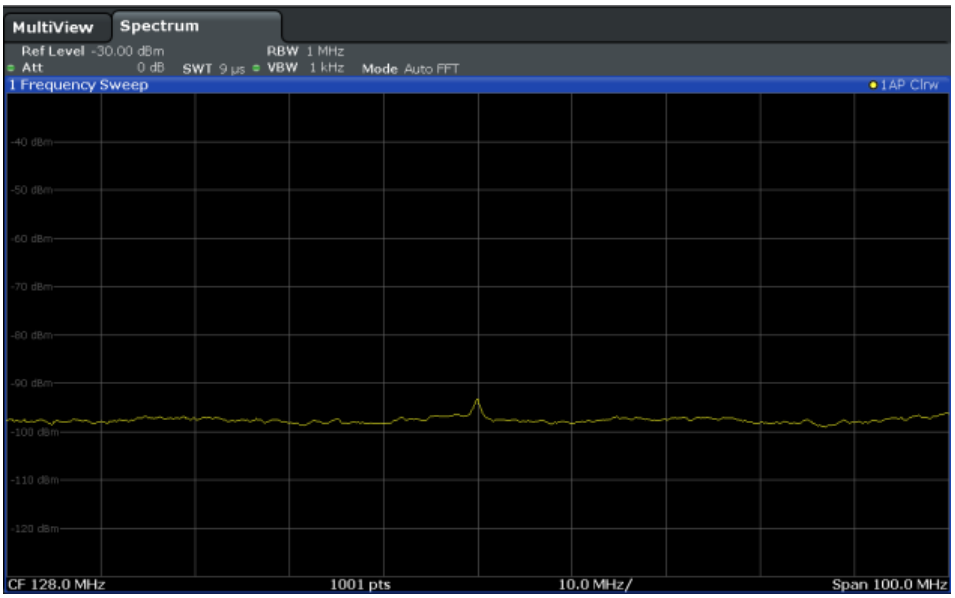


Fig. 2-3: RF sine wave signal with low S/N ratio with a smaller video bandwidth

8. By reducing the resolution bandwidth by a factor of 10, the noise is reduced by 10 dB. Set the RBW to *100 kHz*.

The displayed noise is reduced by approximately 10 dB. The signal, therefore, emerges from noise by about 10 dB. Compared to the previous setting, the video bandwidth has remained the same, i.e. it has increased relative to the smaller resolution bandwidth. The averaging effect of the video bandwidth is therefore reduced. The trace will be noisier.

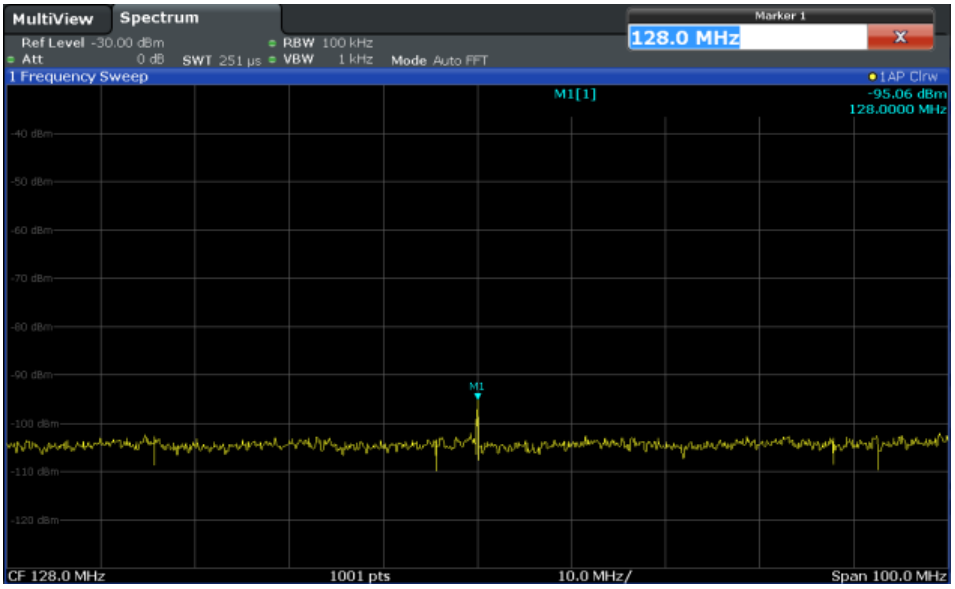


Fig. 2-4: Reference signal at a smaller resolution bandwidth

2.2.4 Measurement Examples - Measuring Signal Spectra with Multiple Signals

- Separating Signals by Selecting the Resolution Bandwidth 24
- Measuring the Modulation Depth of an AM-Modulated Carrier in the Frequency Domain 28
- Measuring AM-Modulated Signals 29

2.2.4.1 Separating Signals by Selecting the Resolution Bandwidth

A basic feature of a Signal and Spectrum Analyzer is the ability to separate the spectral components of a mixture of signals. The resolution at which the individual components can be separated is determined by the resolution bandwidth. Selecting a resolution bandwidth that is too large may make it impossible to distinguish between spectral components, i.e. they are displayed as a single component (see also chapter 3.5.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth", on page 256).

Two signals with the same amplitude can be resolved if the resolution bandwidth is smaller than or equal to the frequency spacing of the signal. If the resolution bandwidth is equal to the frequency spacing, the spectrum display shows a level drop of 3 dB precisely in the center of the two signals. Decreasing the resolution bandwidth makes the level drop larger, which thus makes the individual signals clearer.

In this measurement example we will analyze two signals with a level of -30 dBm each and a frequency spacing of 30 kHz.

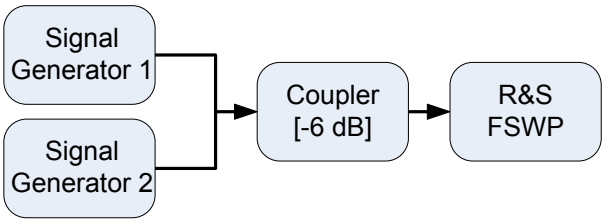


Fig. 2-5: Test setup

Table 2-3: Signal generator settings (e.g. R&S SMW)

	Level	Frequency
Signal generator 1	-30 dBm	128,00 MHz
Signal generator 2	-30 dBm	128,03 MHz

1. Select PRESET to reset the instrument.
2. Enter the Spectrum application via the MODE key.
3. Set the center frequency to *128.015 MHz*.
4. Set the frequency span to *300 kHz*.
5. Set the resolution bandwidth to *30 kHz* and the video bandwidth to *1 kHz*.

   Note: Larger video bandwidths. The video bandwidth is set to 1 kHz in order to make the level drop in the center of the two signals clearly visible. At larger video bandwidths, the video voltage that results from envelope detection is not sufficiently suppressed. This produces additional voltages, which are visible in the trace, in the transition area between the two signals.

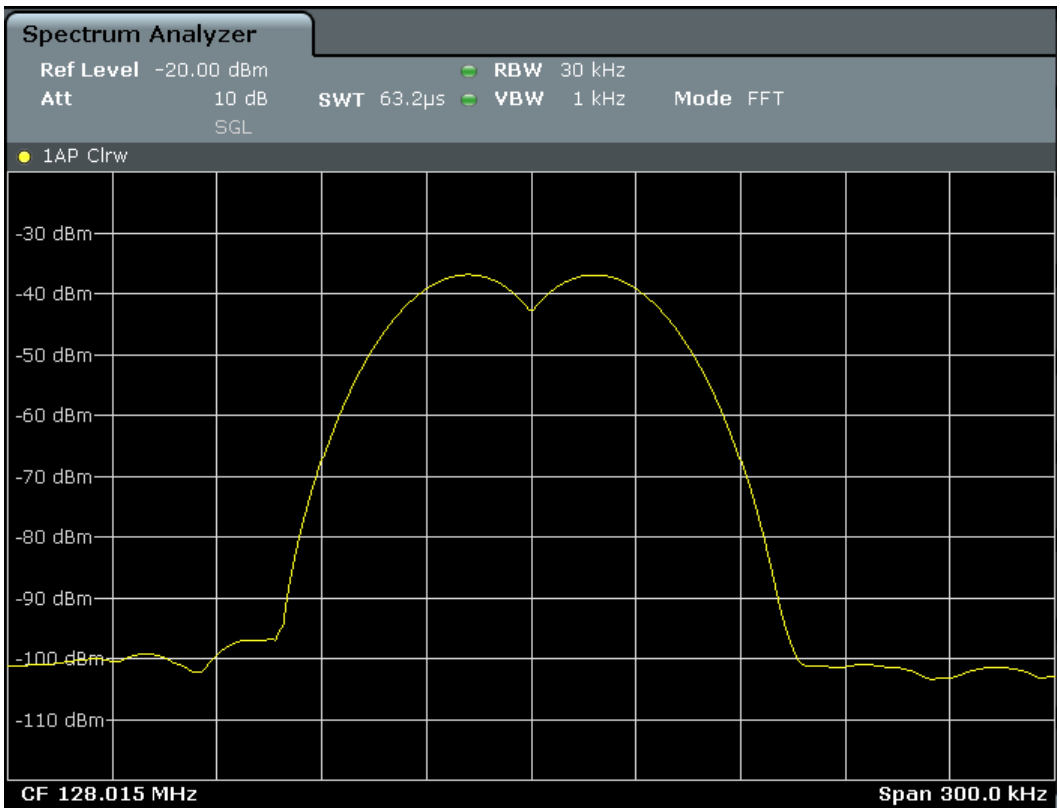


Fig. 2-6: Measurement of two equally-leveled RF sinusoidal signals with the resolution bandwidth which corresponds to the frequency spacing of the signals

Matching generator and R&S FSWP frequencies

The level drop is located exactly in the center of the display only if the generator frequencies match the frequency display of the R&S FSWP exactly. To achieve exact matching, the frequencies of the generators and the R&S FSWP must be synchronized.

6. Set the resolution bandwidth to *100 kHz*.

   It is no longer possible to clearly distinguish the two generator signals.

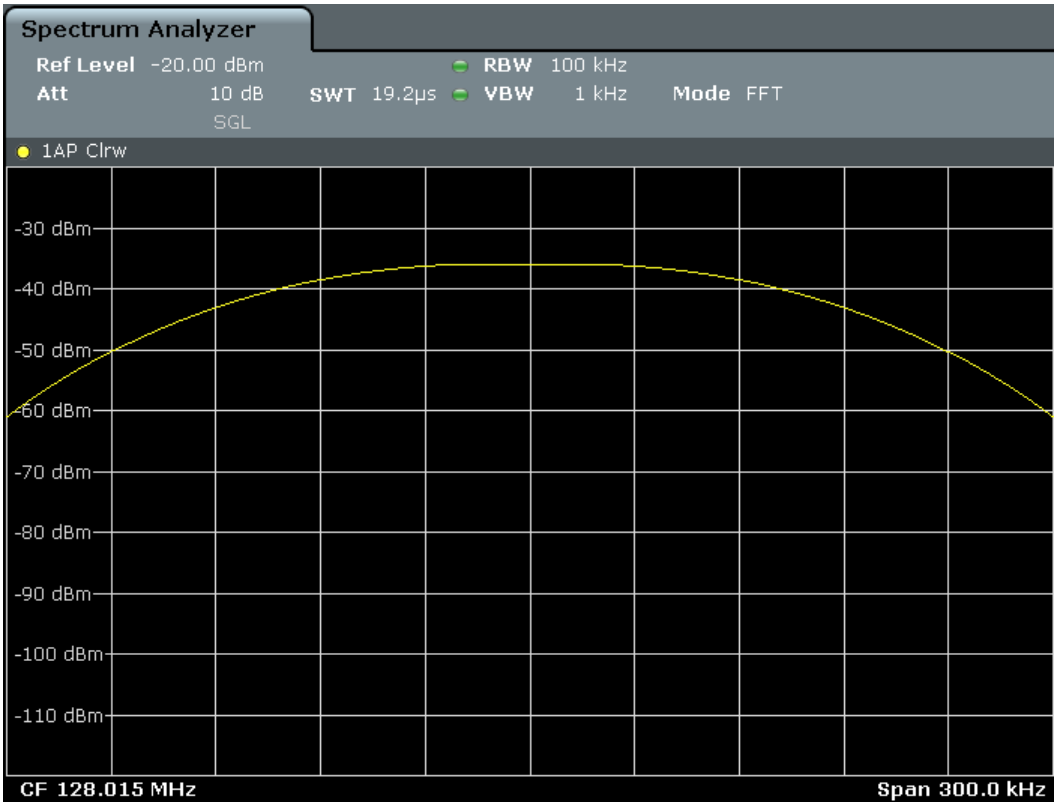


Fig. 2-7: Measurement of two equally-leveled RF sinusoidal signals with a resolution bandwidth which is larger than their frequency spacing

7. Set the resolution bandwidth to *1 kHz*.

   The two generator signals are shown with high resolution. However, the sweep time becomes longer. At smaller bandwidths, the noise display decreases simultaneously (10 dB decrease in noise floor for a decrease in bandwidth by a factor of 10).

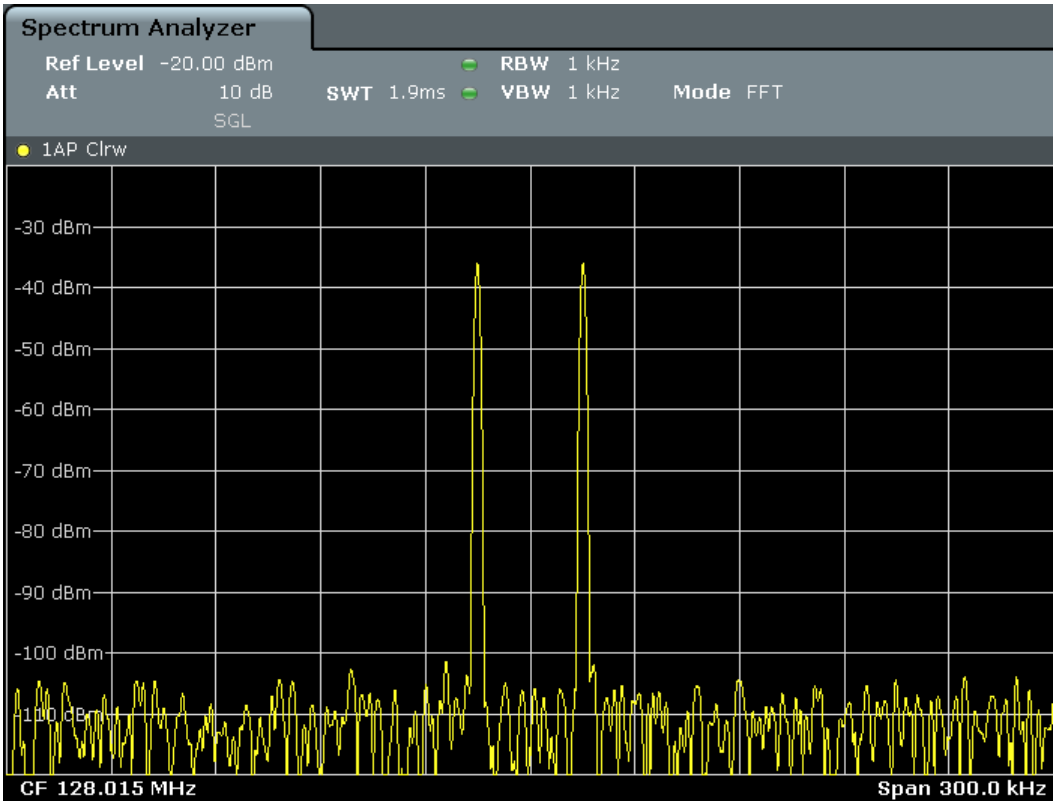


Fig. 2-8: Measurement of two equally-leveled RF sinusoidal signals with a resolution bandwidth (1 kHz) which is significantly smaller than their frequency spacing

2.2.4.2 Measuring the Modulation Depth of an AM-Modulated Carrier in the Frequency Domain

In the frequency range display, the AM side bands can be resolved with a narrow bandwidth and measured separately. The modulation depth of a carrier modulated with a sinusoidal signal can then be measured. Since the dynamic range of a signal analyzer is very large, extremely small modulation depths can also be measured precisely. For this purpose, the R&S FSWP provides measurement routines that output the modulation depth numerically in percent directly.

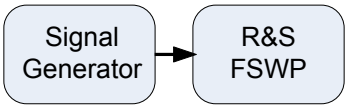


Fig. 2-9: Test setup

Table 2-4: Signal generator settings (e.g. R&S SMW)

Frequency	128 MHz
Level	-30 dBm
Modulation	50 % AM, 10 kHz AF

1. Select PRESET to reset the instrument.
2. Enter the Spectrum application via the MODE key.
3. Set the center frequency to *128 MHz*.
4. Set the frequency span to *50 kHz*.
5. Select MEAS > "AM Modulation Depth" to activate the modulation depth measurement.

   The R&S FSWP automatically sets a marker to the carrier signal in the center of the diagram and one delta marker each to the upper and lower AM sidebands. The R&S FSWP calculates the AM modulation depth from the level differences of the delta markers to the main marker and outputs the numeric value in the marker information.

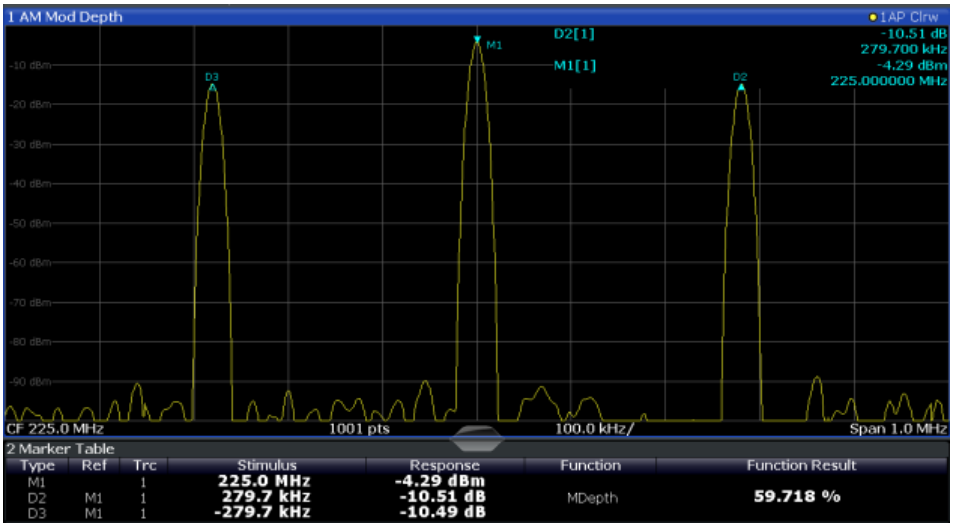


Fig. 2-10: Measurement of the AM modulation depth

The modulation depth is displayed as "MDepth". The frequency of the AF signal can be obtained from the frequency display of the delta marker.

2.2.4.3 Measuring AM-Modulated Signals

The R&S FSWP rectifies the RF input signal (that is, removes the negative parts) and displays it as a magnitude spectrum. The rectification also demodulates AM-modulated signals. The AF voltage can be displayed in zero span if the modulation sidebands fall within the resolution bandwidth.

Displaying the AF of an AM-modulated signal (Zero Span)

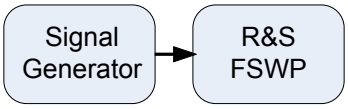


Fig. 2-11: Test setup

Table 2-5: Signal generator settings (e.g. R&S SMW)

Frequency	128 MHz
Level	-30 dBm
Modulation	50 % AM, 1 kHz AF

1. Select PRESET to reset the instrument.
2. Enter the Spectrum application via the MODE key.
3. Set the center frequency to *128 MHz*.
4. Set the frequency span to *0 Hz* or select "Zero Span".
5. Set the sweep time to *2.5 ms*.
6. Set the reference level to *6 dBm* and the display range to linear (AMPT > "Scale Config" > "Scaling: Linear Percent").
7. Define triggering in response to the AF signal using the video trigger to produce a static image.
   a) Press the TRIG key.
   b) Select "Video".
   c) Set the "Trg/Gate Level" to *50%*.

   The trigger level is displayed as a horizontal line across the entire measurement diagram. The R&S FSWP displays the 1 kHz AF signal as a static image in zero span.

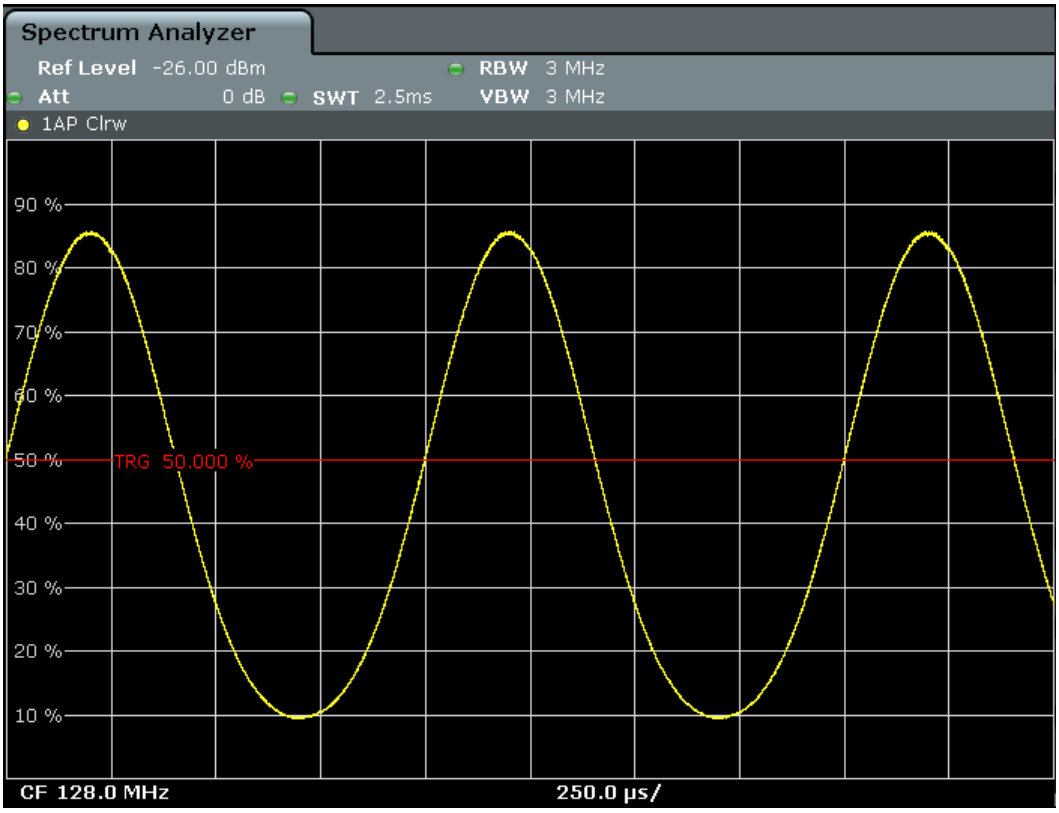


Fig. 2-12: Measurement of the AF signal of a carrier that is AM-modulated with 1 kHz

2.2.5 Measurement Examples in Zero Span

For radio transmission systems that use the TDMA method (for example, GSM), transmission quality is determined not only by spectral characteristics but also by characteristics in zero span. A timeslot is assigned to each user since several users share the same frequency. Smooth operation is ensured only if all users adhere exactly to their assigned timeslots.

Both the power during the send phase as well as the timing and duration of the TDMA burst, and rise and fall times of the burst, are important.

- Measuring the Power Characteristic of Burst Signals 31
- Measuring the Signal-to-Noise Ratio of Burst Signals 35

2.2.5.1 Measuring the Power Characteristic of Burst Signals

To measure power in zero span, the R&S FSWP offers easy-to-use functions that measure the power over a predefined time.

Measuring the Power of a GSM Burst During the Activation Phase

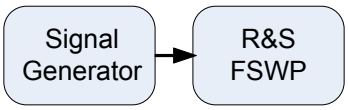


Fig. 2-13: Test setup

Table 2-6: Signal generator settings (e.g. R&S SMW)

Frequency	890 MHz
Level	0 dBm
Modulation	GSM, one timeslot activated

1. Select PRESET to reset the instrument.
2. Enter the Spectrum application via the MODE key.
3. Set the center frequency to *890 MHz* (FREQ).
4. Set the frequency span to *0 Hz* (SPAN > "Zero Span").
5. Set the reference level to *10 dBm* (= level of the signal generator +10 dB) (AMPT).
6. Set the attenuation to *20 dB* (AMPT > "Rf Atten Manual").
7. Set the resolution bandwidth to *1 MHz* (BW > "Res BW").
8. Set the sweep time to *1 ms* (SWEEP > "Sweeptime Manual").

   The R&S FSWP shows the GSM burst continuously across the display.
9. Using the video trigger, set triggering on the rising edge of the burst.
   a) Press the TRIG key.
   b) Set the "Trg/Gate Source" to "Video".
   c) Set the "Trg/Gate Level" to *70%*.

   The R&S FSWP shows a static image with the GSM burst at the start of the trace. The trigger level is displayed as a horizontal line labeled with the absolute level for the trigger threshold in the measurement diagram.
10. Activate power measurement within the activation phase of the burst in zero span.
    a) Press the MEAS key.
    b) Select "Time Domain Power".
    c) Select "Time Dom Power Config".
    d) Set the "Limits" state to "On".
    e) Select the "Left Limit" input field.
    f) By turning the rotary knob clockwise, move the vertical line "S1" to the start of the burst.
    g) Select the "Right Limit" input field.

h) By turning the rotary knob clockwise, move the vertical line "S2" to the end of the burst.

The R&S FSWP displays the average (mean) power during the activation phase of the burst.

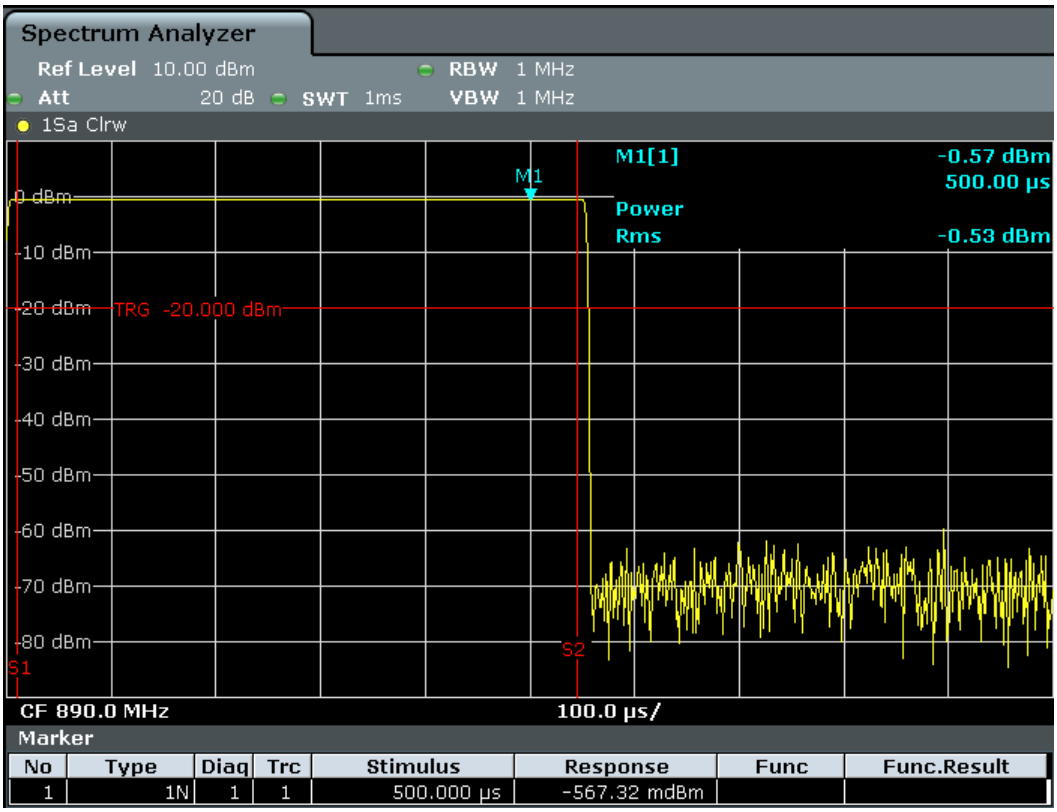


Fig. 2-14: Measurement of the average power during the burst of a GSM signal

Measuring the Edges of a GSM Burst with High Time Resolution

Due to the high time resolution of the R&S FSWP at the 0 Hz display range, the edges of TDMA bursts can be measured precisely. The edges can be shifted to the display area using the trigger offset.

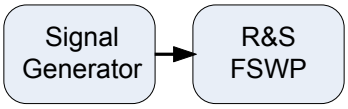


Fig. 2-15: Test setup

Table 2-7: Signal generator settings (e.g. R&S SMW)

Frequency	890 MHz
Level	0 dBm
Modulation	GSM, one timeslot activated

The measurement is based on the example "Measuring the Power of a GSM Burst During the Activation Phase" on page 32.

1. Switch off the power measurement.
   a) Press the MEAS key.
   b) Select "All Functions Off".
2. Increase the time resolution to *100 µs* (SWEEP > "Sweeptime Manual").
3. Shift the rising edge of the GSM burst to the center of the display by defining a trigger offset.
   a) Press the TRIG key.
   b) Select "Trigger Offset".
   c) By turning the rotary knob counterclockwise, reduce the trigger offset until the burst edge is displayed in the center of the display, or enter *-50 µs*.
   The R&S FSWP displays the rising edge of the GSM burst.

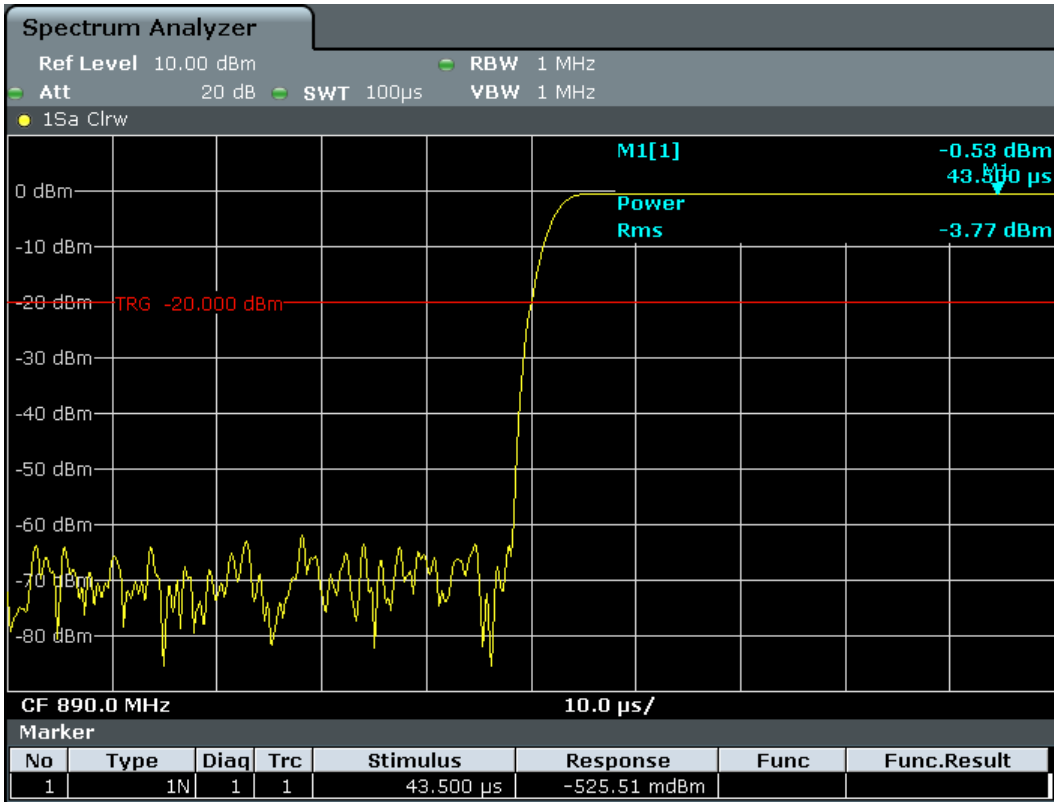


Fig. 2-16: Rising edge of the GSM burst displayed with high time resolution

4. Move the falling edge of the burst to the center of the display. To do so, switch the trigger "Slope" to "Falling" (TRIG > "Trigger/Gate Config").

   The R&S FSWP displays the falling edge of the GSM burst.

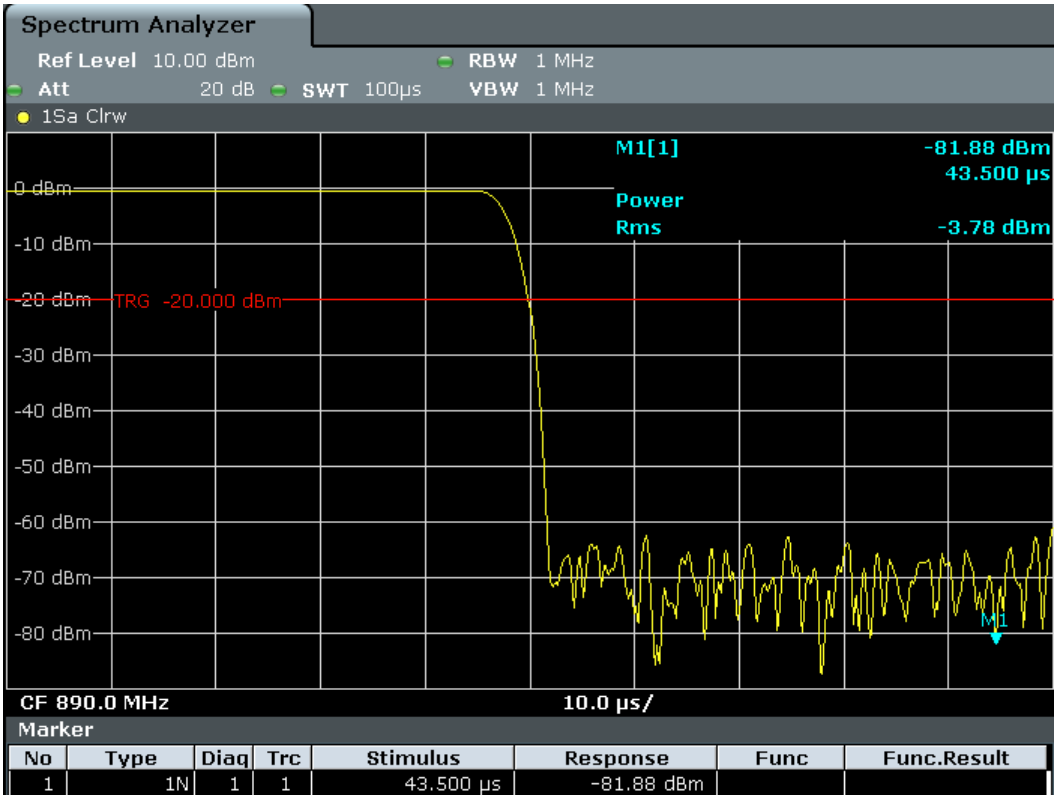


Fig. 2-17: Falling edge of the GSM burst displayed with high time resolution

2.2.5.2 Measuring the Signal-to-Noise Ratio of Burst Signals

When TDMA transmission methods are used, the signal-to-noise ratio or the dynamic range for deactivation can be measured by comparing the power values during the activation phase and the deactivation phase of the transmission burst. Therefore, the R&S FSWP provides a measurement for absolute and relative power in zero span. In the following example, the measurement is performed using a GSM burst.

Signal-to-Noise Ratio of a GSM Signal

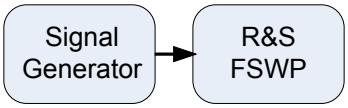


Fig. 2-18: Test setup

Table 2-8: Signal generator settings (e.g. R&S SMW)

Frequency	890 MHz
Level	0 dBm
Modulation	GSM, one time slot is switched on

1. Select PRESET to reset the instrument.

2. Enter the Spectrum application via the MODE key.
3. Set the center frequency to *890 MHz*.
4. Set the frequency span to *0 Hz*.
5. Set the resolution bandwidth to *1 MHz*.
6. Set the reference level to *0 dBm* (= level of the signal generator).
7. Set the sweep time to *2 ms* (SWEEP > "Sweeptime Manual").

   The R&S FSWP shows the GSM burst continuously across the display.
8. Use the trigger source "Video" and the trigger slope "Rising" to trigger on the rising edge of the burst and shift the start of the burst to the center of the display (see step 3 in "Measuring the Edges of a GSM Burst with High Time Resolution" on page 33).
9. Activate power measurement within the activation phase of the burst in zero span.
   a) Press the MEAS key.
   b) Select "Time Domain Power".
   c) Select "Time Dom Power Config".
   d) Set the "Limits" state to "On".
   e) Select the "Left Limit" input field.
   f) By turning the rotary knob clockwise, move the vertical line "S1" to the start of the burst.
   g) Select the "Right Limit" input field.
   h) By turning the rotary knob clockwise, move the vertical line "S2" to the end of the burst.
10. Measure the power during the deactivation phase of the burst by switching the trigger slope to "Falling" (TRIG > "Trigger/Gate Config").

    The R&S FSWP initiates triggering in response to the falling edge of the burst. This shifts the burst to the left-hand side of the measurement diagram. The power is measured in the deactivation phase.

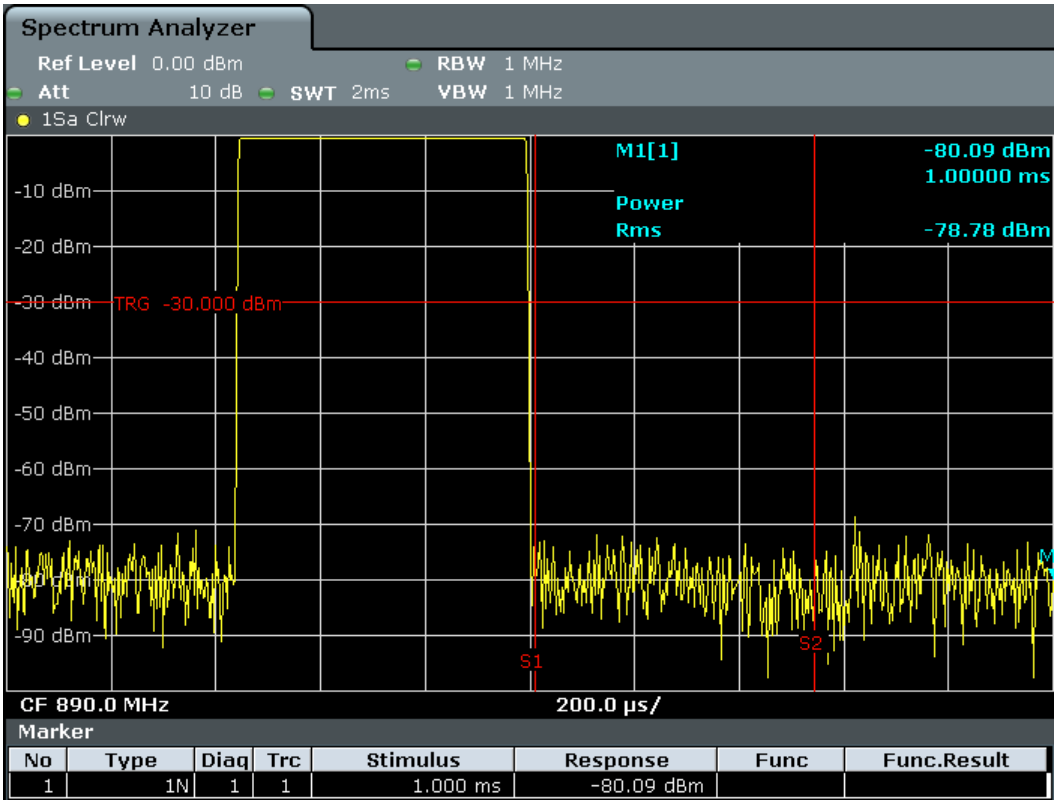


Fig. 2-19: Measurement of the signal-to-noise ratio of a GSM burst signal in zero span

2.3 Channel Power and Adjacent-Channel Power (ACLR) Measurement

Measuring the power in channels adjacent to the carrier or transmission channel is useful to detect interference. The results are displayed as a bar chart for the individual channels.

- About Channel Power Measurements 38
- Channel Power Results 38
- Channel Power Basics 40
- Channel Power Configuration 51
- MSR ACLR Configuration 62
- How to Perform Channel Power Measurements 77
- Measurement Examples 82
- Optimizing and Troubleshooting the Measurement 85
- Reference: Predefined CP/ACLR Standards 86

2.3.1 About Channel Power Measurements

Measuring channel power and adjacent channel power is one of the most important tasks for a signal analyzer with the necessary test routines in the field of digital transmission. While, theoretically, channel power could be measured at highest accuracy with a power meter, its low selectivity means that it is not suitable for measuring adjacent channel power as an absolute value or relative to the transmit channel power. The power in the adjacent channels can only be measured with a selective power meter.

A signal analyzer cannot be classified as a true power meter, because it displays the IF envelope voltage. However, it is calibrated such as to correctly display the power of a pure sine wave signal irrespective of the selected detector. This calibration cannot be applied for non-sinusoidal signals. Assuming that the digitally modulated signal has a Gaussian amplitude distribution, the signal power within the selected resolution bandwidth can be obtained using correction factors. These correction factors are normally used by the signal analyzer's internal power measurement routines in order to determine the signal power from IF envelope measurements. These factors apply if and only if the assumption of a Gaussian amplitude distribution is correct.

Apart from this common method, the R&S FSWP also has a true power detector, i.e. an RMS detector. It displays the power of the test signal within the selected resolution bandwidth correctly, irrespective of the amplitude distribution, without additional correction factors being required.

The R&S FSWP allows you to perform ACLR measurements on input containing multiple signals for different communication standards. A measurement standard is provided that allows you to define multiple discontiguous transmit channels at specified frequencies, independent from the selected center frequency. The ACLR measurement determines the power levels of the individual transmit, adjacent, and gap channels, as well as the total power for each sub block of transmit channels.

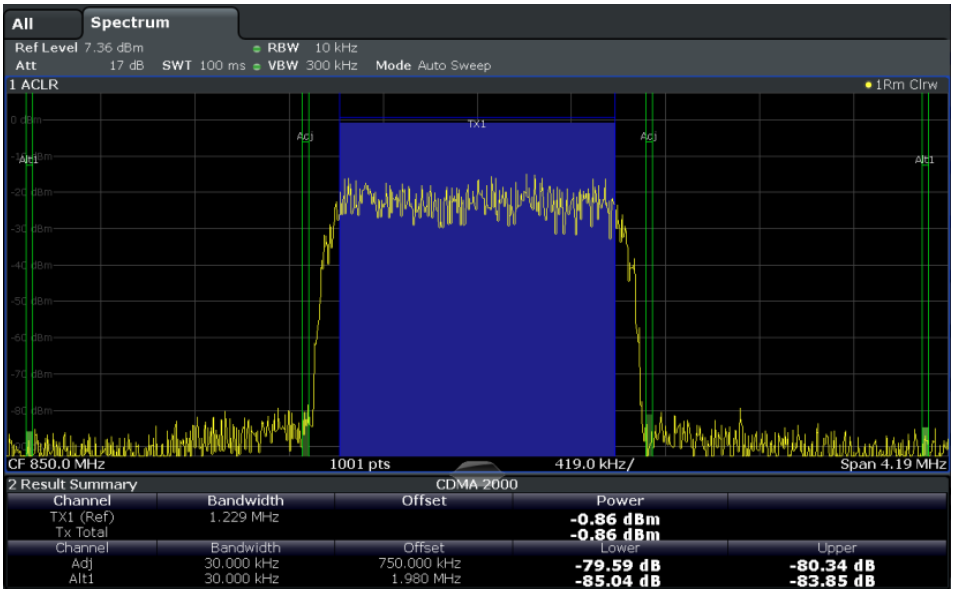
A detailed measurement example is provided in chapter 2.3.7, "Measurement Examples", on page 82.

2.3.2 Channel Power Results

For channel or adjacent-channel power measurements, the individual channels are indicated by different colored bars in the diagram. The height of each bar corresponds to the measured power of that channel. In addition, the name of the channel ("Adj", "Alt1", "TX1", etc., or a user-defined name) is indicated above the bar (separated by a line which has no further meaning). For "Fast ACLR" measurements, which are performed in the time domain, the power versus time is shown for each channel.

Multi-standard radio (MSR) channel power results

The channel power results for MSR signals is described in chapter 2.3.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 47.



Results are provided for the TX channel and the number of defined adjacent channels *above and below* the TX channel. If more than one TX channel is defined, the carrier channel to which the relative adjacent-channel power values should be referenced must be defined. By default, this is the TX channel with the maximum power.

Table 2-9: Measurements performed depending on the number of adjacent channels

0	Only the channel powers are measured.
1	The channel powers and the power of the upper and lower adjacent channel are measured.
2	The channel powers, the power of the upper and lower adjacent channel, and of the next higher and lower channel (alternate channel 1) are measured.
3	The channel power, the power of the upper and lower adjacent channel, the power of the next higher and lower channel (alternate channel 1), and of the next but one higher and lower adjacent channel (alternate channel 2) are measured.
…	…
12	The channel power, the power of the upper and lower adjacent channel, and the power of all the higher and lower channels (alternate channels 1 to 11) are measured.

In the R&S FSWP's display, only the first neighboring channel of the carrier (TX) channel is labelled "Adj" (adjacent) channel; all others are labelled "Alt" (alternate) channels. In this manual, "adjacent" refers to both adjacent and alternate channels.

The measured power values for the TX and adjacent channels are also output as a table in the Result Summary window. Which powers are measured depends on the number of configured channels.

For each channel, the following values are displayed:

Label	Description
Channel	Channel name as specified in the "Channel Settings" (see "Channel Names" on page 61).
Bandwidth	Configured channel bandwidth (see "Channel Bandwidths" on page 59)
Offset	Offset of the channel to the TX channel (configured channel spacing, see "Channel Bandwidths" on page 59)
Power (Lower/Upper)	The measured power values for the TX and lower and upper adjacent channels. The powers of the transmission channels are output in dBm or dBm/Hz, or in dBc, relative to the specified reference TX channel.

Retrieving Results via Remote Control

All or specific channel power measurement results can be retrieved using the `CALC:MARK:FUNC:POW:RES?` command from a remote computer (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?` on page 408). Alternatively, the results can be output as channel power density, i.e. in reference to the measurement bandwidth.

Furthermore, the measured power values of the displayed trace can be retrieved as usual using the `TRAC:DATA?` commands (see `TRACe<n>[:DATA]` on page 606). In this case, the measured power value for each sweep point (by default 1001) is returned.

2.3.3 Channel Power Basics

Some background knowledge on basic terms and principles used in channel power measurements is provided here for a better understanding of the required configuration settings.

- Measurement Methods 40
- Measurement Repeatability 42
- Recommended Common Measurement Parameters 43
- Measurement on Multi-Standard Radio (MSR) Signals 47

2.3.3.1 Measurement Methods

The channel power is defined as the integration of the power across the channel bandwidth.

The **A**djacent **C**hannel **L**eakage Power **R**atio (ACLR), also known as the **A**djacent **C**hannel **P**ower **R**atio (ACPR), is defined as the ratio between the total power of the adjacent channel to the carrier channel's power. An ACLR measurement with several carrier channels (also known as transmission or TX channels) is also possible and is referred to as a "multicarrier ACLR measurement".

There are two possible methods for measuring channel and adjacent channel power with a signal analyzer:

- **IBW method** (**I**ntegration **B**and**W**idth method)

- **Fast ACLR** (Zero-span method), i.e. using a channel filter

IBW method

When measuring the channel power, the R&S FSWP integrates the linear power which corresponds to the levels of the measurement points within the selected channel. The signal analyzer uses a resolution bandwidth which is far smaller than the channel bandwidth. When sweeping over the channel, the channel filter is formed by the pass-band characteristics of the resolution bandwidth.

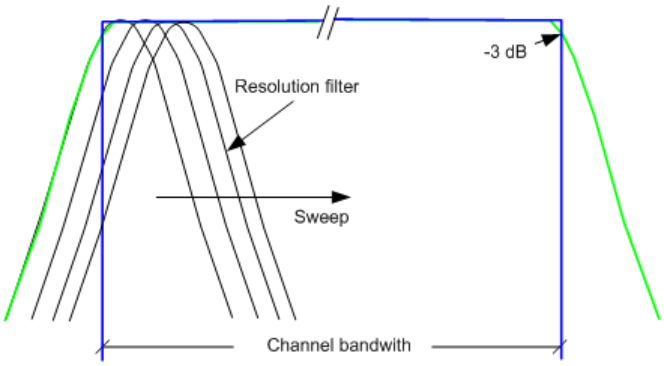


Fig. 2-20: Approximating the channel filter by sweeping with a small resolution bandwidth

The following steps are performed:

1. The linear power of all the trace points within the channel is calculated.
   $P_i = 10^{(Li/10)}$
   where P_i = power of the trace pixel i
   L_i = displayed level of trace point i
2. The powers of all trace points within the channel are summed up and the sum is divided by the number of trace points in the channel.
3. The result is multiplied by the quotient of the selected channel bandwidth and the noise bandwidth of the resolution filter (RBW).

Since the power calculation is performed by integrating the trace within the channel bandwidth, this method is called the IBW method (**I**ntegration **B**and**w**idth method).

Fast ACLR

The integrated bandwidth method (IBW) calculates channel power and ACLR from the trace data obtained during a continuous sweep over the selected span. Most parts of this sweep are neither part of the channel itself nor the defined adjacent channels. Therefore, most of the samples taken during the sweep time cannot be used for channel power or ACLR calculation.

To decrease the measurement times, the R&S FSWP offers a "Fast ACLR" mode. In Fast ACLR mode, the power of the frequency range between the channels of interest is not measured, because it is not required for channel power or ACLR calculation. The

measurement time per channel is set with the sweep time. It is equal to the selected measurement time divided by the selected number of channels.

In the "Fast ACLR" mode, the R&S FSWP measures the power of each channel in the time domain, with the defined channel bandwidth, at the center frequency of the channel in question. The digital implementation of the resolution bandwidths makes it possible to select filter characteristics that are precisely tailored to the signal. In case of CDMA2000, for example, the power in the useful channel is measured with a bandwidth of 1.23 MHz and that of the adjacent channels with a bandwidth of 30 kHz. Therefore the R&S FSWP changes from one channel to the other and measures the power at a bandwidth of 1.23 MHz or 30 kHz using the RMS detector.

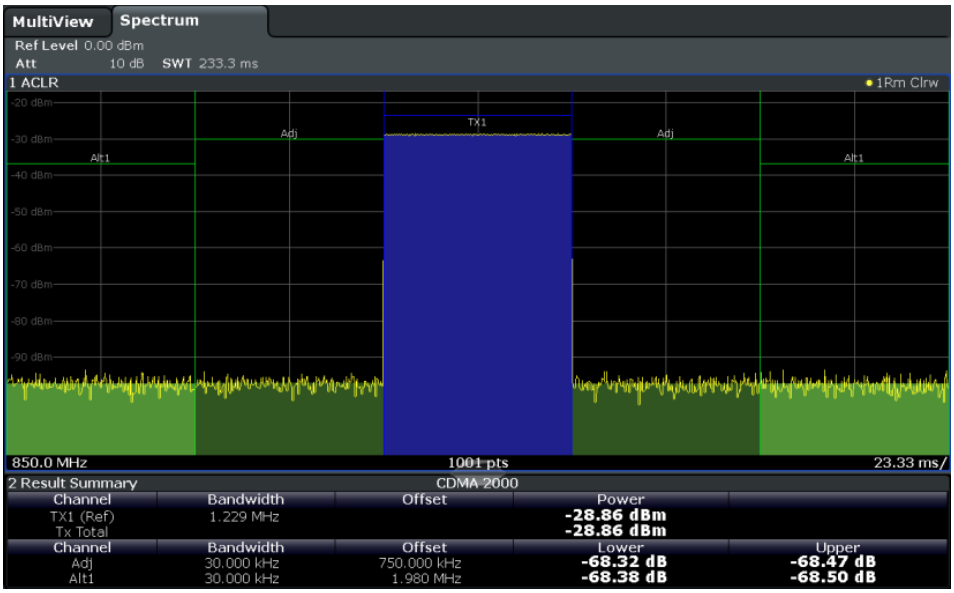


Fig. 2-21: Measuring the channel power and adjacent channel power ratio for CDMA2000 signals with zero span (Fast ACLR)

2.3.3.2 Measurement Repeatability

The repeatability of the results, especially in the narrow adjacent channels, strongly depends on the measurement time for a given resolution bandwidth. A longer sweep time may increase the probability that the measured value converges to the true value of the adjacent channel power, but obviously increases measurement time.

Assuming a measurement with five channels (1 channel plus 2 lower and 2 upper adjacent channels) and a sweep time of 100 ms, a measurement time per channel of 20 ms is required. The number of effective samples taken into account for power calculation in one channel is the product of sweep time in channel times the selected resolution bandwidth.

Assuming a sweep time of 100 ms, there are (30 kHz / 4.19 MHz) * 100 ms * 10 kHz ≈ 7 samples. Whereas in Fast ACLR mode, there are (100 ms / 5) * 30 kHz ≈ 600 samples. Comparing these numbers explains the increase of repeatability with a 95% confidence level (2δ) from ± 2.8 dB to ± 0.34 dB for a sweep time of 100 ms.

For the same repeatability, the sweep time would have to be set to 8.5 s with the integration method. The figure 2-22 shows the standard deviation of the results as a function of the sweep time.

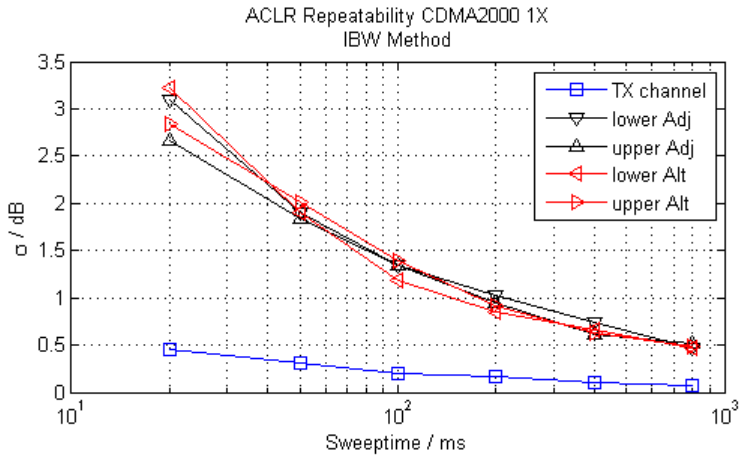


Fig. 2-22: Repeatability of adjacent channel power measurement on CDMA2000 standard signals if the integration bandwidth method is used

The figure 2-23 shows the repeatability of power measurements in the transmit channel and of relative power measurements in the adjacent channels as a function of sweep time. The standard deviation of measurement results is calculated from 100 consecutive measurements. Take scaling into account if comparing power values.

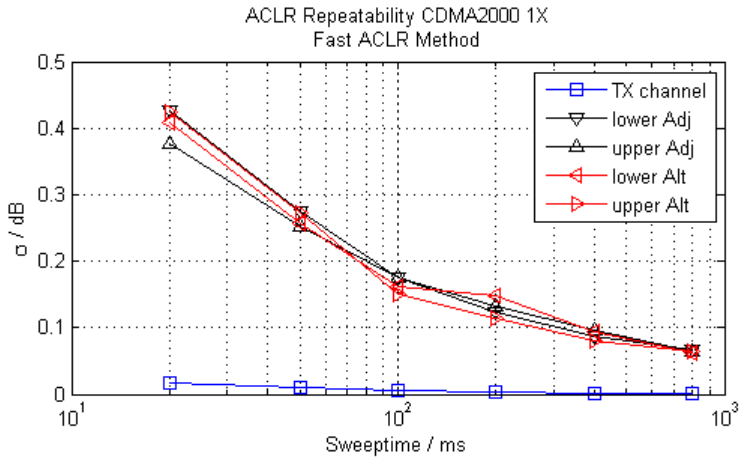


Fig. 2-23: Repeatability of adjacent channel power measurements on CDMA2000 signals in the fast ACLR mode

2.3.3.3 Recommended Common Measurement Parameters

The following sections provide recommendations on the most important measurement parameters for channel power measurements.

All instrument settings for the selected channel setup (channel bandwidth, channel spacing) can be optimized automatically using the "Adjust Settings" function (see "Optimized Settings (Adjust Settings)" on page 57).

The easiest way to configure a measurement is using the configuration "Overview", see chapter 3.1, "Configuration Overview", on page 193.

Sweep Time

The sweep time is selected depending on the desired reproducibility of results. Reproducibility increases with sweep time since power measurement is then performed over a longer time period. As a general approach, it can be assumed that approx. 500 non-correlated measured values are required for a reproducibility of 0.5 dB (99 % of the measurements are within 0.5 dB of the true measured value). Approx. 5000 measured values are required for a reproducibility of 0.1 dB (99 %). This holds true for white noise. The measured values are considered as non-correlated if their time interval corresponds to the reciprocal of the measured bandwidth.

The number of A/D converter values, N, used to calculate the power, is defined by the sweep time. The time per trace pixel for power measurements is directly proportional to the selected sweep time.

If the sample detector is used, it is best to select the smallest sweep time possible for a given span and resolution bandwidth. The minimum time is obtained if the setting is coupled. This means that the time per measurement is minimal. Extending the measurement time does not have any advantages as the number of samples for calculating the power is defined by the number of trace points in the channel.

If the RMS detector is used, the repeatability of the measurement results can be influenced by the selection of sweep times. Repeatability is increased at longer sweep times.

If the RMS detector is used, the number of samples can be estimated as follows:

Since only uncorrelated samples contribute to the RMS value, the number of samples can be calculated from the sweep time and the resolution bandwidth.

Samples can be assumed to be uncorrelated if sampling is performed at intervals of 1/RBW. The number of uncorrelated samples is calculated as follows:

N_{decorr} = SWT * RBW

(N_{decorr} means uncorrelated samples)

The number of uncorrelated samples per trace pixel is obtained by dividing N_{decorr} by 1001 (= pixels per trace).

The "Sweep Time" can be defined using the softkey in the "Ch Power" menu or in the "Sweep" configuration dialog box (see "Sweep Time" on page 58).

Frequency Span

The frequency span must cover at least the channels to be measured plus a measurement margin of approximately 10 %.

If the frequency span is large in comparison to the channel bandwidth (or the adjacent-channel bandwidths) being analyzed, only a few points on the trace are available per channel. This reduces the accuracy of the waveform calculation for the channel filter used, which has a negative effect on the measurement accuracy. It is therefore strongly recommended that the formulas mentioned be taken into consideration when selecting the frequency span.

The frequency span for the defined channel settings can be optimized using the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "Optimized Settings (Adjust Settings)" on page 57). You can set the frequency span manually in the "Frequency" configuration dialog box, see chapter 3.3.3, "How To Define the Frequency Range", on page 245.

For channel power measurements the "Adjust Settings" function sets the frequency span as follows:

"(No. of transmission channels – 1) x transmission channel spacing + 2 x transmission channel bandwidth + measurement margin"

For adjacent-channel power measurements, the "Adjust Settings" function sets the frequency span as a function of the number of transmission channels, the transmission channel spacing, the adjacent-channel spacing, and the bandwidth of one of adjacent-channels ADJ, ALT1 or ALT2, whichever is furthest away from the transmission channels:

"(No. of transmission channels – 1) x transmission channel spacing + 2 x (adjacent-channel spacing + adjacent-channel bandwidth) + measurement margin"

The measurement margin is approx. 10 % of the value obtained by adding the channel spacing and the channel bandwidth.

Resolution Bandwidth (RBW)

To ensure both acceptable measurement speed and the required selection (to suppress spectral components outside the channel to be measured, especially of the adjacent channels), the resolution bandwidth must not be selected too small or too large. As a general approach, the resolution bandwidth is to be set to values between 1% and 4% of the channel bandwidth.

A larger resolution bandwidth can be selected if the spectrum within the channel to be measured and around it has a flat characteristic. In the standard setting, e.g. for standard IS95A REV at an adjacent channel bandwidth of 30 kHz, a resolution bandwidth of 30 kHz is used. This yields correct results since the spectrum in the neighborhood of the adjacent channels normally has a constant level.

The resolution bandwidth for the defined channel settings can be optimized using the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "Optimized Settings (Adjust Settings)" on page 57). You can set the RBW manually in the "Bandwidth" configuration dialog box, see "RBW" on page 263.

With the exception of the IS95 CDMA standards, the "Adjust Settings" function sets the resolution bandwidth (RBW) as a function of the channel bandwidth:

"RBW ≤ 1/40 of channel bandwidth"

The maximum possible resolution bandwidth (with respect to the requirement RBW ≤ 1/40) resulting from the available RBW steps (1, 3) is selected.

Video Bandwidth (VBW)

For a correct power measurement, the video signal must not be limited in bandwidth. A restricted bandwidth of the logarithmic video signal would cause signal averaging and thus result in a too low indication of the power (-2.51 dB at very low video bandwidths). The video bandwidth should therefore be selected at least three times the resolution bandwidth:

"VBW ≥ 3 x RBW"

The video bandwidth for the defined channel settings can be optimized using the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "Optimized Settings (Adjust Settings)" on page 57). You can set the VBW manually in the "Bandwidth" configuration dialog box, see "VBW" on page 263.

The video bandwidth (VBW) is set as a function of the channel bandwidth (see formula above) and the smallest possible VBW with regard to the available step size is selected.

Detector

The RMS detector correctly indicates the power irrespective of the characteristics of the signal to be measured. The whole IF envelope is used to calculate the power for each measurement point. The IF envelope is digitized using a sampling frequency which is at least five times the resolution bandwidth which has been selected. Based on the sample values, the power is calculated for each measurement point using the following formula:

$$P_{RMS} = \sqrt{\frac{1}{N}} \cdot \sum_{i=1}^{N} s_i^2$$

where:

s_i = linear digitized video voltage at the output of the A/D converter

N = number of A/D converter values per measurement point

P_{RMS} = power represented by a measurement point

When the power has been calculated, the power units are converted into decibels and the value is displayed as a measurement point.

In principle, the sample detector would be possible as well. Due to the limited number of measurement points used to calculate the power in the channel, the sample detector would yield less stable results.

The RMS detector can be set for the defined channel settings automatically using the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "Optimized Settings (Adjust Settings)" on page 57).

You can set the detector manually in the "Traces" configuration dialog box, see "Detector" on page 328.

Trace Averaging

Averaging, which is often performed to stabilize the measurement results, leads to a level indication that is too low and should therefore be avoided. The reduction in the displayed power depends on the number of averages and the signal characteristics in the channel to be measured.

The "Adjust Settings" function switches off trace averaging. You can deactivate the trace averaging manually in the "Traces" configuration dialog box, see "Average Mode" on page 329.

Reference Level

To achieve an optimum dynamic range, the reference level has to be set such that the signal is as close to the reference level as possible without forcing an overload message or limiting the dynamic range by an S/N ratio that is too small. Since the measurement bandwidth for channel power measurements is significantly smaller than the signal bandwidth, the signal path may be overloaded although the trace is still significantly below the reference level.

The reference level is not influenced by the selection of a predefined standard or by the automatic setting adjustment. The reference level can be set automatically using the "Auto Level" function in the AUTO SET menu, or manually in the "Amplitude" menu.

2.3.3.4 Measurement on Multi-Standard Radio (MSR) Signals

Modern base stations may contain multiple signals for different communication standards. A new measurement standard is provided for the R&S FSWP ACLR measurement that allows you to measure such MSR signals, including non-contiguous setups. Multiple (also non-)contiguous transmit channels can be specified at absolute frequencies, independent from the common center frequency selected for display.

Signal structure

Up to 18 transmit channels can be grouped in a maximum of 5 *sub blocks*. Between two sub blocks, two gaps are defined: a *lower gap* and an *upper gap*. Each gap in turn contains 2 channels (*gap channels*). The channels in the upper gap are identical to those in the lower gap, but inverted. To either side of the outermost transmit channels, lower and upper adjacent channels can be defined as in common ACLR measurement setups.

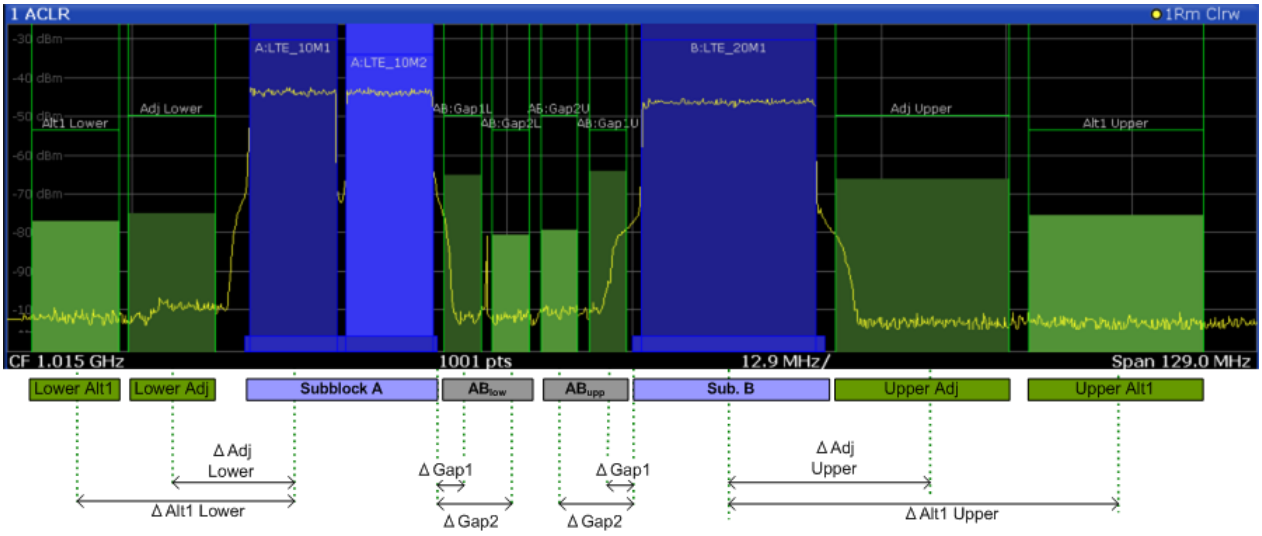


Fig. 2-24: MSR signal structure

Sub block and channel definition

The sub blocks are defined by a specified center frequency, RF bandwidth, and number of transmit channels.

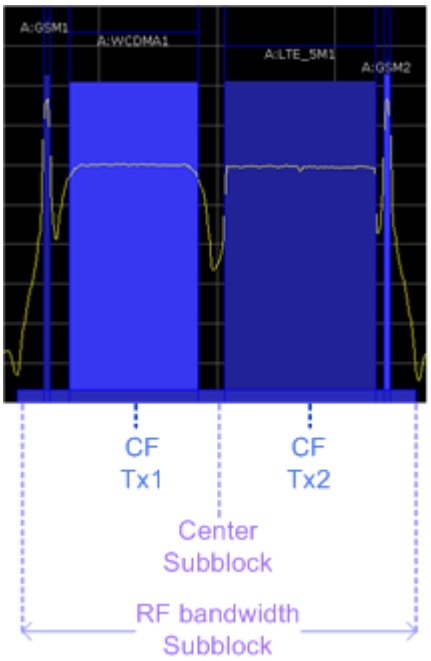


Fig. 2-25: Sub block definition

As opposed to common ACLR channel definitions, the Tx channels are defined at absolute frequencies, rather than by a spacing relative to the (common) center frequency. Each transmit channel can be assigned a different technology, used to predefine the required bandwidth.

Gap channels and CACLR

If two or more sub blocks are defined, the power in the gaps between the sub blocks must also be measured. Gap channels are defined using bandwidths and spacings, relative to the outer edges of the surrounding sub blocks. Since the upper and lower gap channels are symmetrical, only two gap channels must be configured. The required spacing can be determined according to the following formula (indicated for lower channels):

Spacing = [CF of the gap channel] - [left sub block center] + ([RF bandwidth of left sub block] /2)

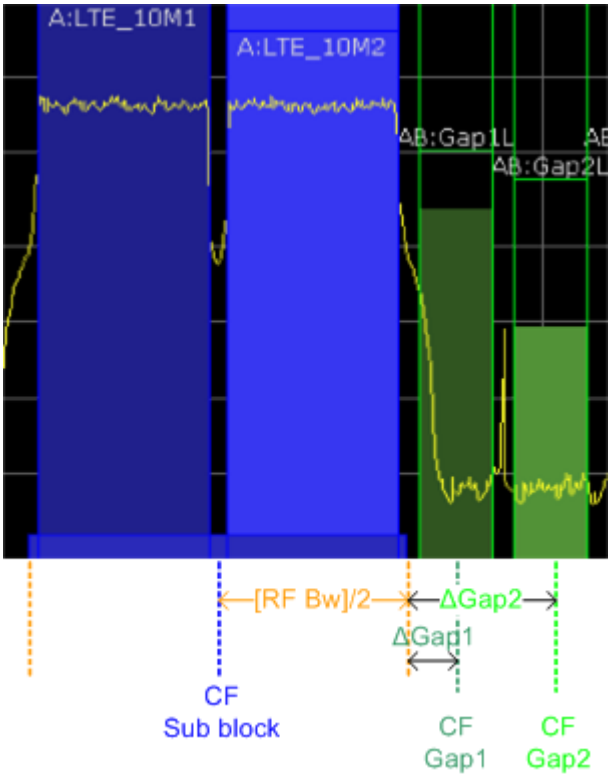


Fig. 2-26: Gap channel definition for lower gap

According to the MSR standard, the ***C**umulative **A**djacent **C**hannel **L**eakage **R**atio (CACLR) power* must be determined for the gap channels. The CACLR power is measured in the two gap channels for the upper and lower gap. The power in the gap channels is then set in relation to the power of the two closest transmission channels to either side of the gap. The CACLR power for the gap channels is indicated in the Result Summary.

In addition, the ACLR power for the individual gap channels is indicated in the Result Summary. The ACLR power of the lower gap channels refers to the TX channel to the left of the gap, while the ACLR power of the upper gap channels refers to the TX channel to the right of the gap. A separate relative limit value can be defined for the ACLR power.

Adjacent channels

Adjacent channels are defined as in common ACLR measurements using bandwidths and spacings, relative to the uppermost or lowermost transmit channels in the sub blocks (see also figure 2-24):

- The spacing of the lower adjacent channels refers to the CF of the first Tx channel in the first sub block.
- The spacing of the upper adjacent channels refers to the CF of the last Tx channel in the last sub block.

The upper and lower adjacent channels can also be defined asymmetrically (see "Symmetrical Adjacent Setup" on page 68). This is particularly useful if the lowest Tx channel and highest Tx channel use different standards and thus require different bandwidths for adjacent channel power measurement.

Channel display for MSR signals

As in common ACLR measurements, the individual channels are indicated by different colored bars in the diagram. The height of each bar corresponds to the measured power of that channel. In addition, the name of the channel is indicated above the bar. Sub blocks are named A,B,C,D,E and are also indicated by a slim blue bar along the frequency axis.

Tx channel names correspond to the specified technology (for LTE including the bandwidth), followed by a consecutive number. (If the channel is too narrow to display the channel name, it is replaced by "..." on the screen.) The assigned sub block is indicated with the channel name, e.g. "B:LTE_5M1" for the first Tx channel in sub block B that uses the LTE 5 MHz bandwidth technology.

Adjacent and alternate channels are displayed as in common ACLR measurements.

Gap channels are indicated by the names of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B), followed by the channel name ("Gap1" or "Gap2") and an "L" (for lower) or a "U" (for upper). Both the lower and upper gap channels are displayed.

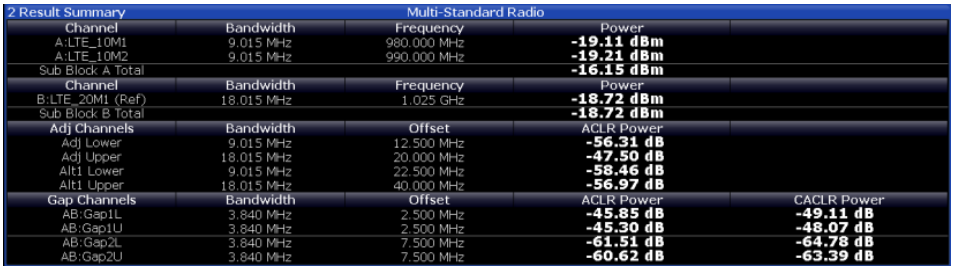
The gap channels can be hidden if they do not reach a minimum size, or deactivated entirely. This enhances the result display, as fewer lines and bars are displayed. If gap channels are deactivated, the power results are not calculated and thus are not shown in the Result Summary table.

Furthermore, channel names for all TX, adjacent, and alternate channels are now user-definable.

Channel power results

The Result Summary for MSR signal measurements is similar to the table for common signals (see chapter 2.3.2, "Channel Power Results", on page 38). However, the Tx channel results are grouped by sub blocks, and sub block totals are provided instead of a total Tx channel power. Instead of the individual channel frequency offsets, the absolute center frequencies are indicated for the transmit channels.

The CACLR and ACLR power results for each gap channel are appended at the end of the table. The CACLR results are calculated as the power in the gap channel divided by the power sum of the two closest transmission channels to either side of it.



2 Result Summary		Multi-Standard Radio		
Channel	Bandwidth	Frequency	Power	
A:LTE_10M1	9.015 MHz	980.000 MHz	-19.11 dBm	
A:LTE_10M2	9.015 MHz	990.000 MHz	-19.21 dBm	
Sub Block A Total			-16.15 dBm	
Channel	Bandwidth	Frequency	Power	
B:LTE_20M1 (Ref)	18.015 MHz	1.025 GHz	-18.72 dBm	
Sub Block B Total			-18.72 dBm	
Adj Channels	Bandwidth	Offset	ACLR Power	
Adj Lower	9.015 MHz	12.500 MHz	-56.31 dB	
Adj Upper	18.015 MHz	20.000 MHz	-47.50 dB	
Alt1 Lower	9.015 MHz	22.500 MHz	-58.46 dB	
Alt1 Upper	18.015 MHz	40.000 MHz	-56.97 dB	
Gap Channels	Bandwidth	Offset	ACLR Power	CACLR Power
AB:Gap1L	3.840 MHz	2.500 MHz	-45.85 dB	-49.11 dB
AB:Gap1U	3.840 MHz	2.500 MHz	-45.30 dB	-48.07 dB
AB:Gap2L	3.840 MHz	7.500 MHz	-61.51 dB	-64.78 dB
AB:Gap2U	3.840 MHz	7.500 MHz	-60.62 dB	-63.39 dB

Fig. 2-27: Result summary for asymmetrical channel definition

Remote command:

`CALCulate:MARKer:FUNCtion:POWer<sb>:RESult? GACLr` or
`CALCulate:MARKer:FUNCtion:POWer<sb>:RESult? MACM` , see
`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?` on page 408

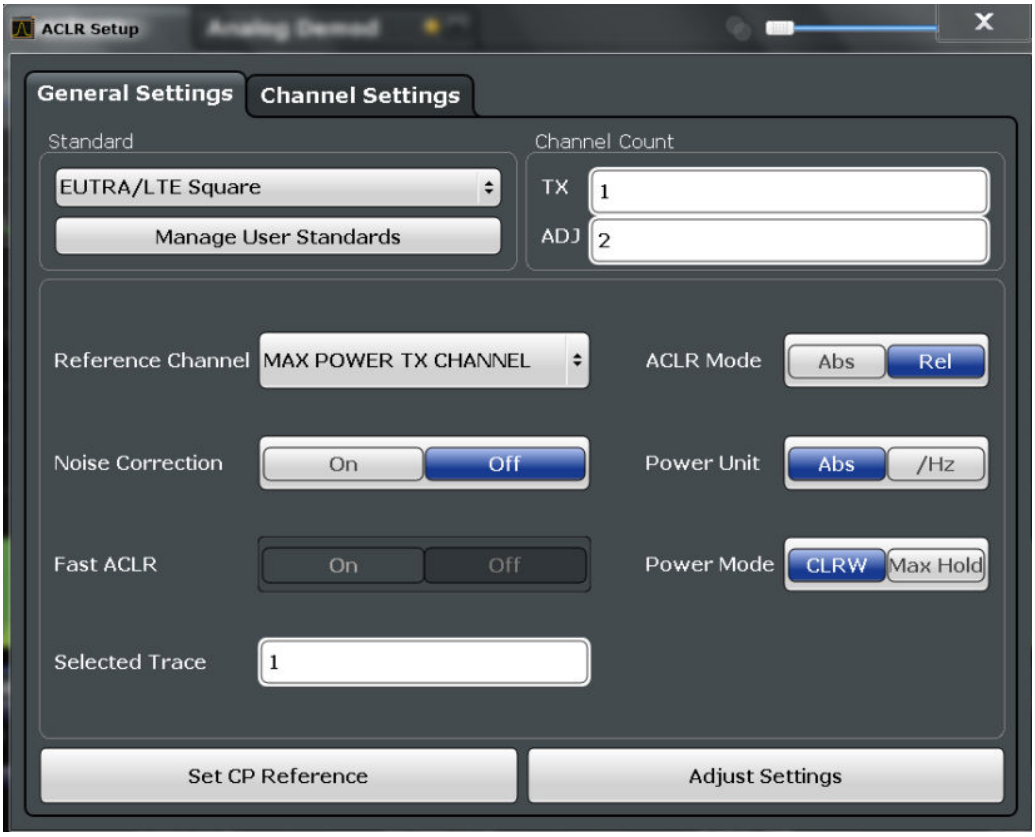
Restrictions and dependencies

As the signal structure in multi-standard radio signals may vary considerably, the channels can be defined very flexibly for the ACLR measurement with the R&S FSWP. No checks or limitations are implemented concerning the channel definitions, apart from the maximum number of channels to be defined. Thus, you will not be notified if transmit channels for a specific sub block lie outside the sub block's defined frequency range, or if transmit and gap channels overlap.

2.3.4 Channel Power Configuration

Channel Power (CP) and Adjacent-Channel Power (ACLR) measurements are selected via the "Channel Power ACLR" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "ACLR Setup" dialog box, which is displayed when you select the "CP/ACLR Config" softkey from the "CH Power" menu.

If the "Multi-Standard Radio" standard is selected (see "Standard" on page 53), the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box. See chapter 2.3.5, "MSR ACLR Configuration", on page 62 for a description of these settings.



The easiest way to configure a measurement is using the configuration "Overview", see chapter 3.1, "Configuration Overview", on page 193.

The remote commands required to perform these tasks are described in chapter 5.2.4, "Measuring the Channel Power and ACLR", on page 412.

- General CP/ACLR Measurement Settings....52
- Channel Setup....58

2.3.4.1 General CP/ACLR Measurement Settings

General measurement settings are defined in the "ACLR Setup" dialog, in the "General Settings" tab.

Standard....53
└ Predefined Standards....53
└ User-Defined Standards....53
Number of Channels (Tx, ADJ)....55
Reference Channel....55
Noise cancellation....56
Fast ACLR....56
Selected Trace....56
Absolute and Relative Values (ACLR Mode)....56
Channel Power Levels and Density (Power Unit)....56

Power Mode....57
Setting a Fixed Reference for Channel Power Measurements (Set CP Reference)....57
Optimized Settings (Adjust Settings)....57
Sweep Time....58

Standard
The main measurement settings can be stored as a standard file. When such a standard is loaded, the required channel and general measurement settings are automatically set on the R&S FSWP. However, the settings can be changed. Predefined standards are available for standard measurements, but standard files with user-defined configurations can also be created.

Note: If the "Multi-Standard Radio" standard is selected, the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box (see chapter 2.3.5, "MSR ACLR Configuration", on page 62).
If any other predefined standard (or "NONE") is selected, the "ACLR Setup" dialog box is restored (see chapter 2.3.4, "Channel Power Configuration", on page 51).

Note that changes in the configuration are not stored when the dialog boxes are exchanged.

Predefined Standards ← Standard
Predefined standards contain the main measurement settings for standard measurements. When such a standard is loaded, the required channel settings are automatically set on the R&S FSWP. However, the settings can be changed.

The predefined standards contain the following settings:

- Channel bandwidths
- Channel spacings
- Detector
- Trace Average setting
- Resolution Bandwidth (RBW)
- Weighting Filter

Predefined standards can be selected via the "CP/ACLR Standard" softkey in the "CH Power" menu or in the "General Settings" tab of the "CP/ACLR Setup" dialog box.

For details on the available standards see chapter 2.3.9, "Reference: Predefined CP/ACLR Standards", on page 86.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412

User-Defined Standards ← Standard
In addition to the predefined standards you can save your own standards with your specific measurement settings in an xml file so you can use them again at a later time. User-defined standards are stored on the instrument in the `C:\R_S\instr\acp_std` directory.

A sample file is provided for an MSR ACLR measurement (MSR_ACLRExample.xml). It sets up the measurement for the MSR signal generator waveform described in the file `C:\R_S\instr\user\waveform\MSRA_GSM_WCDMA_LET_GSM.wv`.

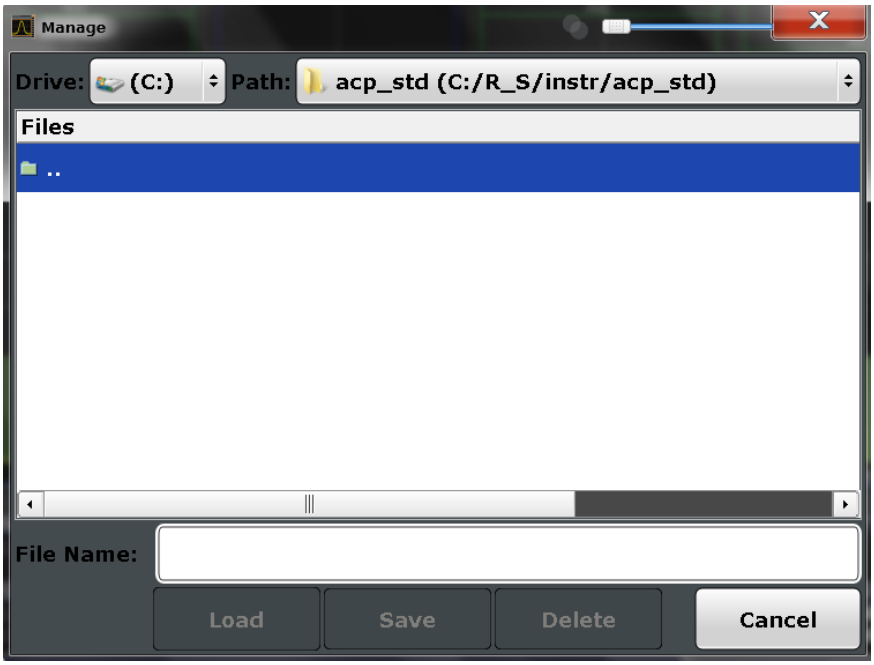
Note that ACLR user standards are not supported for Fast ACLR and multicarrier ACLR measurements.

Note: User standards created on an analyzer of the R&S FSP family are compatible to the R&S FSWP. User standards created on an R&S FSWP, however, are not necessarily compatible to the analyzers of the R&S FSP family and may not work there.

The following parameter definitions are saved in a user-defined standard:

- Number of adjacent channels
- Channel bandwidth of transmission (Tx), adjacent (Adj) and alternate (Alt) channels
- Channel spacings
- Weighting filters
- Resolution bandwidth
- Video bandwidth
- Detector
- ACLR limits and their state
- Sweep time and sweep time coupling
- Trace and power mode
- (MSR only: sub block and gap channel definition)

User-defined standards are managed in the "Manage" dialog box which is displayed when you select the "Manage User Standards" button in the "General Settings" tab of the "CP/ACLR Setup" dialog box.



In the "Manage" dialog box you can save the current measurement settings as a user-defined standard, or load a stored measurement configuration. Furthermore, you can delete an existing configuration file.

For details see chapter 2.3.6.4, "How to Manage User-Defined Configurations", on page 80.

Remote command:
To query all available standards:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:CATalog?` on page 413
To load a standard:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412
To save a standard:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:SAVE` on page 413
To delete a standard:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:DELete` on page 413

Number of Channels (Tx, ADJ)
Up to 18 carrier channels and up to 12 adjacent channels can be defined.

Results are provided for the Tx channel and the number of defined adjacent channels *above and below* the Tx channel. If more than one Tx channel is defined, the carrier channel to which the relative adjacent-channel power values should be referenced must be defined (see "Reference Channel" on page 55).

Note: If several carriers (Tx channels) are activated for the measurement, the number of sweep points is increased to ensure that adjacent-channel powers are measured with adequate accuracy.

For more information on how the number of channels affects the measured powers, see chapter 2.3.2, "Channel Power Results", on page 38.

Remote command:
Number of Tx channels:
`[SENSe:]POWer:ACHannel:TXCHannel:COUNt` on page 417
Number of Adjacent channels:
`[SENSe:]POWer:ACHannel:ACPairs` on page 414

Reference Channel
The measured power values in the adjacent channels can be displayed relative to the transmission channel. If more than one Tx channel is defined, you must select which one is to be used as a reference channel.

Tx Channel 1	Transmission channel 1 is used. (Not available for MSR ACLR)
Min Power Tx Channel	The transmission channel with the lowest power is used as a reference channel.
Max Power Tx Channel	The transmission channel with the highest power is used as a reference channel (Default).
Lowest & Highest Channel	The outer left-hand transmission channel is the reference channel for the lower adjacent channels, the outer right-hand transmission channel that for the upper adjacent channels.

Remote command:
`[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual` on page 421
`[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO` on page 420

Noise cancellation
The results can be corrected by the instrument's inherent noise, which increases the dynamic range.

In this case, a reference measurement of the instrument's inherent noise is carried out. The measured noise power is then subtracted from the power in the channel that is being analyzed (first active trace only).

The inherent noise of the instrument depends on the selected center frequency, resolution bandwidth and level setting. Therefore, the correction function is disabled whenever one of these parameters is changed. A disable message is displayed on the screen. To enable the correction function after changing one of these settings, activate it again. A new reference measurement is carried out.

Noise cancellation is also available in zero span.

Currently, noise cancellation is only available for the following trace detectors:

- RMS
- Average
- Sample
- Positive Peak

Remote command:
`[SENSe:]POWer:NCORrection` on page 575

Fast ACLR
If activated, instead of using the IBW method, the R&S FSWP sets the center frequency to the different channel center frequencies consecutively and measures the power with the selected measurement time (= sweep time/number of channels).

Remote command:
`[SENSe:]POWer:HSPeed` on page 427

Selected Trace
The CP/ACLR measurement can be performed on any active trace.

Remote command:
`[SENSe:]POWer:TRACe` on page 412

Absolute and Relative Values (ACLR Mode)
The powers of the adjacent channels are output in dBm or dBm/Hz (absolute values), or in dBc, relative to the specified reference Tx channel.

"Abs" The absolute power in the adjacent channels is displayed in the unit of the y-axis, e.g. in dBm, dBµV.

"Rel" The level of the adjacent channels is displayed relative to the level of the transmission channel in dBc.

Remote command:
`[SENSe:]POWer:ACHannel:MODE` on page 443

Channel Power Levels and Density (Power Unit)
By default, the channel power is displayed in absolute values. If "/Hz" is activated, the channel power density is displayed instead. Thus, the absolute unit of the channel power is switched from dBm to dBm/Hz.

Note: The channel power density in dBm/Hz corresponds to the power inside a bandwidth of 1 Hz and is calculated as follows:
"channel power density = channel power – $\log_{10}$(channel bandwidth)"

Thus you can measure the signal/noise power density, for example, or use the additional functions Absolute and Relative Values (ACLR Mode) and Reference Channel to obtain the signal to noise ratio.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult:PHZ` on page 442

Power Mode
The measured power values can be displayed directly for each trace ("Clear/Write"), or only the maximum values over a series of measurements can be displayed ("Max Hold"). In the latter case, the power values are calculated from the current trace and compared with the previous power value using a maximum algorithm. The higher value is retained. If "Max Hold" mode is activated, "Pwr Max" is indicated in the table header. Note that the *trace* mode remains unaffected by this setting.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:MODE` on page 408

Setting a Fixed Reference for Channel Power Measurements (Set CP Reference)
For pure channel power measurements (no adjacent channels defined) with only one Tx channel, the currently measured channel power can be used as a fixed reference value for subsequent channel power measurements.

When you select this button, the channel power currently measured on the Tx channel is stored as a fixed reference power. In the following channel power measurements, the power is indicated relative to the fixed reference power. The reference value is displayed in the "Reference" field (in relative ACLR mode); the default value is 0 dBm.

Note: In adjacent-channel power measurement, the power is always referenced to a transmission channel (see "Reference Channel" on page 55), thus, this function is not available.

Remote command:
`[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE` on page 420

Optimized Settings (Adjust Settings)
All instrument settings for the selected channel setup (channel bandwidth, channel spacing) can be optimized automatically.

The adjustment is carried out only once. If necessary, the instrument settings can be changed later.

The following settings are optimized by "Adjust Settings":

- "Frequency Span" on page 44
- "Resolution Bandwidth (RBW)" on page 45
- "Video Bandwidth (VBW)" on page 46
- "Detector" on page 46
- "Trace Averaging" on page 47

Note: The reference level is not affected by this function. To adjust the reference level automatically, use the Setting the Reference Level Automatically (Auto Level) function in the AUTO SET menu.

Remote command:
`[SENSe:]POWer:ACHannel:PRESet` on page 411

Sweep Time
With the RMS detector, a longer sweep time increases the stability of the measurement results. For recommendations on setting this parameter, see "Sweep Time" on page 44.

The sweep time can be set via the softkey in the "Ch Power" menu and is identical to the general setting in the "Sweep" configuration dialog box.

Remote command:
`[SENSe:]SWEep:TIME` on page 588

2.3.4.2 Channel Setup

The "Channel Settings" tab in the "ACLR Setup" dialog box provides all the channel settings to configure the channel power or ACLR measurement. You can define the channel settings for all channels, independent of the defined number of *used* Tx or adjacent channels (see "Number of Channels (Tx, ADJ)" on page 55).

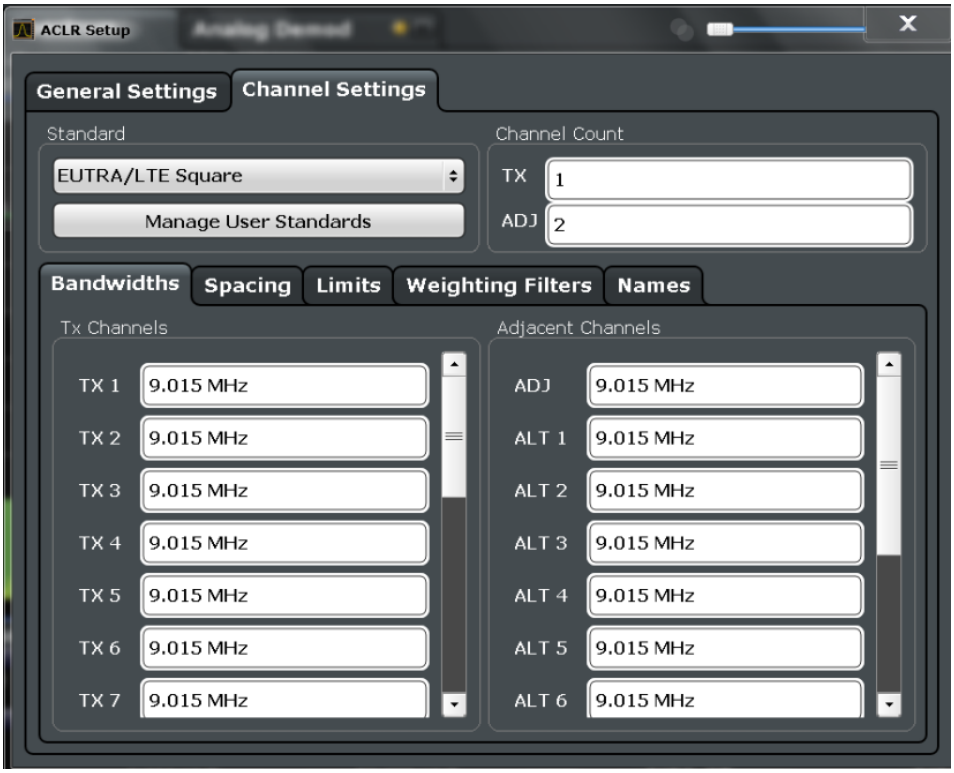
For details on setting up channels, see chapter 2.3.6.2, "How to Set up the Channels", on page 78.

In addition to the specific channel settings, the general settings "Standard" on page 53 and "Number of Channels (Tx, ADJ)" on page 55 are also available in this tab.

The following settings are available in individual subtabs of the "Channel Settings" tab.

Channel Bandwidths 59
Channel Spacings 59
Limit Checking 60
Weighting Filters 61
Channel Names 61

Channel Bandwidths



The Tx channel bandwidth is normally defined by the transmission standard.

The correct bandwidth is set automatically for the selected standard. The bandwidth for each channel is indicated by a colored bar in the display.

For measurements that require channel bandwidths which deviate from those defined in the selected standard, use the IBW method ("Fast ACLR Off"). With the IBW method, the channel bandwidth borders are right and left of the channel center frequency. Thus, you can visually check whether the entire power of the signal under test is within the selected channel bandwidth.

The value entered for any Tx channel is automatically also defined for all subsequent Tx channels. Thus, only one value needs to be entered if all Tx channels have the same bandwidth.

The value entered for any ADJ or ALT channel is automatically also defined for all alternate (ALT) channels. Thus, only one value needs to be entered if all adjacent channels have the same bandwidth.

Remote command:
`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>]` on page 415
`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ACHannel` on page 414
`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ALTernate<ch>` on page 414

Channel Spacings

Channel spacings are normally defined by the transmission standard but can be changed.

If the spacings are not equal, the channel distribution in relation to the center frequency is as follows:

Odd number of Tx channels	The middle Tx channel is centered to center frequency.
Even number of Tx channels	The two Tx channels in the middle are used to calculate the frequency between those two channels. This frequency is aligned to the center frequency.

The spacings between all Tx channels can be defined individually. When you change the spacing for one channel, the value is automatically also defined for all subsequent Tx channels in order to set up a system with equal Tx channel spacing quickly. For different spacings, a setup from top to bottom is necessary.

Tx1-2	spacing between the first and the second carrier
Tx2-3	spacing between the second and the third carrier
…	…

If you change the adjacent-channel spacing (ADJ), all higher adjacent channel spacings (ALT1, ALT2, …) are multiplied by the same factor (new spacing value/old spacing value). Again, only one value needs to be entered for equal channel spacing. For different spacing, configure the spacings from top to bottom.

For details see chapter 2.3.6.2, "How to Set up the Channels", on page 78

Remote command:

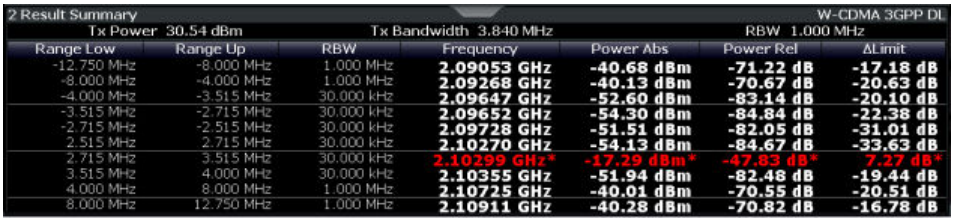
`[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch>` on page 417

`[SENSe:]POWer:ACHannel:SPACing[:ACHannel]` on page 416

`[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch>` on page 416

Limit Checking

During an ACLR measurement, the power values can be checked whether they exceed user-defined or standard-defined limits. A relative or absolute limit can be defined, or both. Both limit types are considered, regardless whether the measured levels are absolute or relative values. The check of both limit values can be activated independently. If any active limit value is exceeded, the measured value is displayed in red and marked by a preceding asterisk in the result table.



2 Result Summary — W-CDMA 3GPP DL

Tx Power 30.54 dBm | Tx Bandwidth 3.840 MHz | RBW 1.000 MHz

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-12.750 MHz	-8.000 MHz	1.000 MHz	2.09053 GHz	-40.68 dBm	-71.22 dB	-17.18 dB
-8.000 MHz	-4.000 MHz	1.000 MHz	2.09268 GHz	-40.13 dBm	-70.67 dB	-20.63 dB
-4.000 MHz	-3.515 MHz	30.000 kHz	2.09647 GHz	-52.60 dBm	-83.14 dB	-20.10 dB
-3.515 MHz	-2.715 MHz	30.000 kHz	2.09652 GHz	-54.30 dBm	-84.84 dB	-22.38 dB
-2.715 MHz	-2.515 MHz	30.000 kHz	2.09728 GHz	-51.51 dBm	-82.05 dB	-31.01 dB
2.515 MHz	2.715 MHz	30.000 kHz	2.10270 GHz	-54.13 dBm	-84.67 dB	-33.63 dB
2.715 MHz	3.515 MHz	30.000 kHz	2.10299 GHz*	-17.29 dBm*	-47.83 dB*	7.27 dB*
3.515 MHz	4.000 MHz	30.000 kHz	2.10355 GHz	-51.94 dBm	-82.48 dB	-19.44 dB
4.000 MHz	8.000 MHz	1.000 MHz	2.10725 GHz	-40.01 dBm	-70.55 dB	-20.51 dB
8.000 MHz	12.750 MHz	1.000 MHz	2.10911 GHz	-40.28 dBm	-70.82 dB	-16.78 dB

The results of the power limit checks are also indicated in the `STATus:QUEStionable:ACPLimit` status registry.

Remote command:
`CALCulate<n>:LIMit<k>:ACPower[:STATe]` on page 426
`CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute:STATe` on page 422
`CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute` on page 422
`CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]:STATe` on page 423
`CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]` on page 422
`CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute:STATe` on page 424
`CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute` on page 424
`CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative]:STATe` on page 425
`CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative]` on page 425
`CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?` on page 423

Weighting Filters
Weighting filters allow you to determine the influence of individual channels on the total measurement result. For each channel you can activate or deactivate the use of the weighting filter and define an individual weighting factor ("Alpha" value).

Weighting filters are not available for all supported standards and cannot always be defined manually where they are available.

Remote command:
Activating/Deactivating:
`[SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch>` on page 420
`[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel` on page 419
`[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch>` on page 419
Alpha value:
`[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch>` on page 419
`[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel` on page 418
`[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch>` on page 418

Channel Names
In the R&S FSWP's display, carrier channels are labelled "Tx" by default; the first neighboring channel is labelled "Adj" (adjacent) channel; all others are labelled "Alt" (alternate) channels. You can define user-specific channel names for each channel which are displayed in the result diagram and result table.

Remote command:
`[SENSe:]POWer:ACHannel:NAME:ACHannel` on page 415
`[SENSe:]POWer:ACHannel:NAME:ALTernate<ch>` on page 415
`[SENSe:]POWer:ACHannel:NAME:CHANnel<ch>` on page 416

2.3.5 MSR ACLR Configuration

ACLR measurements can also be performed on input containing multiple signals for different communication standards. A new measurement standard is provided that allows you to define multiple discontiguous transmit channels at specified frequencies, independent from the selected center frequency. If the "Multi-Standard Radio" standard is selected (see "Standard" on page 53), the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box.

For more information see chapter 2.3.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 47.

The remote commands required to perform these tasks are described in chapter 5.2.4, "Measuring the Channel Power and ACLR", on page 412.

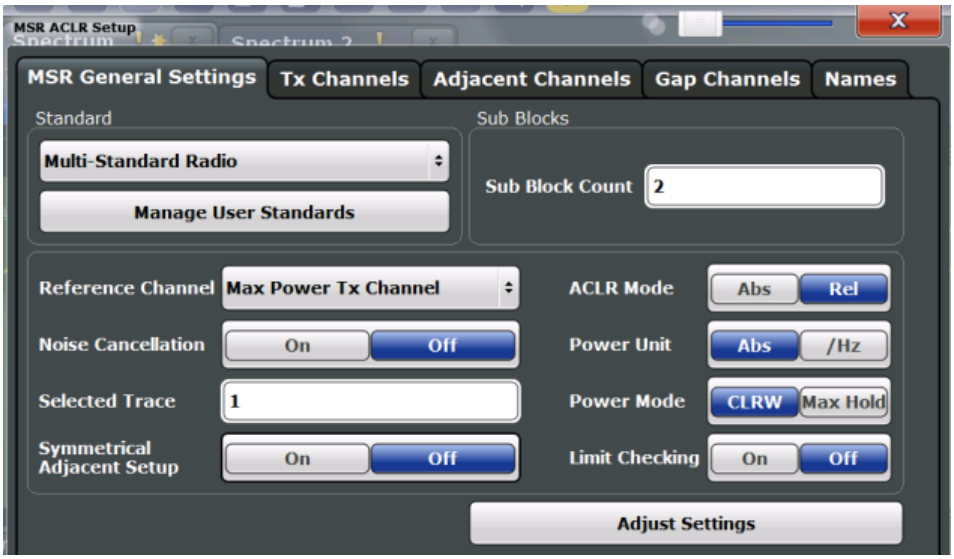
- General MSR ACLR Measurement Settings....62
- MSR Sub Block and Tx Channel Definition....68
- MSR Adjacent Channel Setup....71
- MSR Gap Channel Setup....74
- MSR Channel Names....76

2.3.5.1 General MSR ACLR Measurement Settings

General MSR ACLR measurement settings are defined in the "MSR ACLR Setup" dialog, in the "MSR General Settings" tab.

To display the "MSR ACLR Setup" dialog box, do one of the following:

- From the "CH Power" menu, select the "CP/ACLR Standard" softkey and then select the "Multi-Standard Radio" standard. Then select the "CP/ACLR Config" softkey.
- Select the "CP/ACLR Config" softkey from the "CH Power" menu. Then select the "Multi-Standard Radio" standard from the "Standard" selection list.



Standard....63
└ Predefined Standards....63
└ User-Defined Standards....64
Number of Sub Blocks....65
Reference Channel....65
Noise cancellation....66
Selected Trace....66
Absolute and Relative Values (ACLR Mode)....66
Channel Power Levels and Density (Power Unit)....67
Power Mode....67
Optimized Settings (Adjust Settings)....67
Symmetrical Adjacent Setup....68
Limit Checking....68

Standard
The main measurement settings can be stored as a standard file. When such a standard is loaded, the required channel and general measurement settings are automatically set on the R&S FSWP. However, the settings can be changed. Predefined standards are available for standard measurements, but standard files with user-defined configurations can also be created.

Note: If the "Multi-Standard Radio" standard is selected, the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box (see chapter 2.3.5, "MSR ACLR Configuration", on page 62).
If any other predefined standard (or "NONE") is selected, the "ACLR Setup" dialog box is restored (see chapter 2.3.4, "Channel Power Configuration", on page 51).

Note that changes in the configuration are not stored when the dialog boxes are exchanged.

Predefined Standards ← Standard
Predefined standards contain the main measurement settings for standard measurements. When such a standard is loaded, the required channel settings are automatically set on the R&S FSWP. However, the settings can be changed.

The predefined standards contain the following settings:

- Channel bandwidths
- Channel spacings
- Detector
- Trace Average setting
- Resolution Bandwidth (RBW)
- Weighting Filter

Predefined standards can be selected via the "CP/ACLR Standard" softkey in the "CH Power" menu or in the "General Settings" tab of the "CP/ACLR Setup" dialog box.

For details on the available standards see chapter 2.3.9, "Reference: Predefined CP/ACLR Standards", on page 86.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412

User-Defined Standards ← Standard

In addition to the predefined standards you can save your own standards with your specific measurement settings in an xml file so you can use them again at a later time. User-defined standards are stored on the instrument in the `C:\R_S\instr\acp_std` directory.

A sample file is provided for an MSR ACLR measurement (MSR_ACLRExample.xml). It sets up the measurement for the MSR signal generator waveform described in the file `C:\R_S\instr\user\waveform\MSRA_GSM_WCDMA_LET_GSM.wv`.

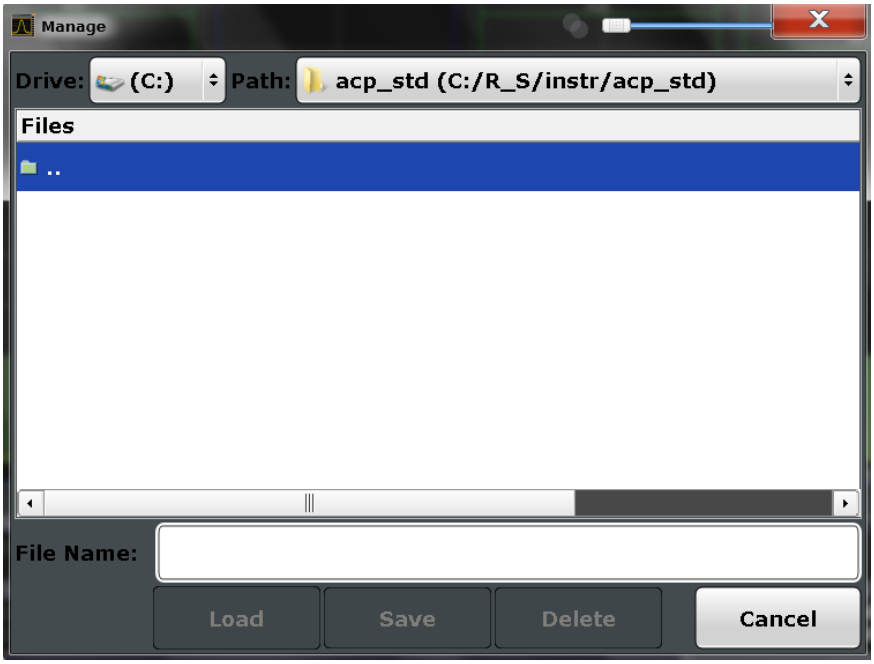
Note that ACLR user standards are not supported for Fast ACLR and multicarrier ACLR measurements.

Note: User standards created on an analyzer of the R&S FSP family are compatible to the R&S FSWP. User standards created on an R&S FSWP, however, are not necessarily compatible to the analyzers of the R&S FSP family and may not work there.

The following parameter definitions are saved in a user-defined standard:

- Number of adjacent channels
- Channel bandwidth of transmission (Tx), adjacent (Adj) and alternate (Alt) channels
- Channel spacings
- Weighting filters
- Resolution bandwidth
- Video bandwidth
- Detector
- ACLR limits and their state
- Sweep time and sweep time coupling
- Trace and power mode
- (MSR only: sub block and gap channel definition)

User-defined standards are managed in the "Manage" dialog box which is displayed when you select the "Manage User Standards" button in the "General Settings" tab of the "CP/ACLR Setup" dialog box.



In the "Manage" dialog box you can save the current measurement settings as a user-defined standard, or load a stored measurement configuration. Furthermore, you can delete an existing configuration file.

For details see chapter 2.3.6.4, "How to Manage User-Defined Configurations", on page 80.

Remote command:
To query all available standards:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:CATalog?` on page 413
To load a standard:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412
To save a standard:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:SAVE` on page 413
To delete a standard:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:DELete` on page 413

Number of Sub Blocks
Defines the number of sub blocks, i.e. groups of transmission channels in an MSR signal.

For more information see chapter 2.3.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 47.

Remote command:
`[SENSe:]POWer:ACHannel:SBCount` on page 437

Reference Channel
The measured power values in the adjacent channels can be displayed relative to the transmission channel. If more than one Tx channel is defined, you must select which one is to be used as a reference channel.

Tx Channel 1	Transmission channel 1 is used. (Not available for MSR ACLR)
Min Power Tx Channel	The transmission channel with the lowest power is used as a reference channel.
Max Power Tx Channel	The transmission channel with the highest power is used as a reference channel (Default).
Lowest & Highest Channel	The outer left-hand transmission channel is the reference channel for the lower adjacent channels, the outer right-hand transmission channel that for the upper adjacent channels.

Remote command:
`[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual` on page 421
`[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO` on page 420

Noise cancellation
The results can be corrected by the instrument's inherent noise, which increases the dynamic range.

In this case, a reference measurement of the instrument's inherent noise is carried out. The measured noise power is then subtracted from the power in the channel that is being analyzed (first active trace only).

The inherent noise of the instrument depends on the selected center frequency, resolution bandwidth and level setting. Therefore, the correction function is disabled whenever one of these parameters is changed. A disable message is displayed on the screen. To enable the correction function after changing one of these settings, activate it again. A new reference measurement is carried out.

Noise cancellation is also available in zero span.

Currently, noise cancellation is only available for the following trace detectors:

- RMS
- Average
- Sample
- Positive Peak

Remote command:
`[SENSe:]POWer:NCORrection` on page 575

Selected Trace
The CP/ACLR measurement can be performed on any active trace.

Remote command:
`[SENSe:]POWer:TRACe` on page 412

Absolute and Relative Values (ACLR Mode)
The powers of the adjacent channels are output in dBm or dBm/Hz (absolute values), or in dBc, relative to the specified reference Tx channel.

"Abs" The absolute power in the adjacent channels is displayed in the unit of the y-axis, e.g. in dBm, dBµV.

"Rel" The level of the adjacent channels is displayed relative to the level of the transmission channel in dBc.

Remote command:
`[SENSe:]POWer:ACHannel:MODE` on page 443

Channel Power Levels and Density (Power Unit)
By default, the channel power is displayed in absolute values. If "/Hz" is activated, the channel power density is displayed instead. Thus, the absolute unit of the channel power is switched from dBm to dBm/Hz.

Note: The channel power density in dBm/Hz corresponds to the power inside a bandwidth of 1 Hz and is calculated as follows:
"channel power density = channel power – $\log_{10}$(channel bandwidth)"

Thus you can measure the signal/noise power density, for example, or use the additional functions Absolute and Relative Values (ACLR Mode) and Reference Channel to obtain the signal to noise ratio.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult:PHZ` on page 442

Power Mode
The measured power values can be displayed directly for each trace ("Clear/Write"), or only the maximum values over a series of measurements can be displayed ("Max Hold"). In the latter case, the power values are calculated from the current trace and compared with the previous power value using a maximum algorithm. The higher value is retained. If "Max Hold" mode is activated, "Pwr Max" is indicated in the table header. Note that the *trace* mode remains unaffected by this setting.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:MODE` on page 408

Optimized Settings (Adjust Settings)
All instrument settings for the selected channel setup (channel bandwidth, channel spacing) can be optimized automatically.

The adjustment is carried out only once. If necessary, the instrument settings can be changed later.

The following settings are optimized by "Adjust Settings":

- "Frequency Span" on page 44
- "Resolution Bandwidth (RBW)" on page 45
- "Video Bandwidth (VBW)" on page 46
- "Detector" on page 46
- "Trace Averaging" on page 47

Note: The reference level is not affected by this function. To adjust the reference level automatically, use the Setting the Reference Level Automatically (Auto Level) function in the AUTO SET menu.

Remote command:
`[SENSe:]POWer:ACHannel:PRESet` on page 411

Symmetrical Adjacent Setup
If enabled, the upper and lower adjacent and alternate channels are defined symmetrically. This is the default behaviour.

If disabled, the upper and lower channels can be configured differently. This is particularly useful if the lowest Tx channel and highest Tx channel use different standards and thus require different bandwidths for adjacent channel power measurement.

Remote command:
`[SENSe:]POWer:ACHannel:SSETup` on page 441

Limit Checking
Activates or deactivates limit checks globally for all adjacent and gap channels. In addition to this setting, limits must be defined and activated individually for each channel.

The results of the power limit checks are also indicated in the `STATus:QUEStionable:ACPLimit` status registry.

Remote command:
`CALCulate<n>:LIMit<k>:ACPower[:STATe]` on page 426

2.3.5.2 MSR Sub Block and Tx Channel Definition

The "Tx Channels" tab in the "MSR ACLR Setup" dialog box provides all the channel settings to configure sub blocks and Tx channels in MSR ACLR measurements.

MSR ACLR Setup
Spectrum 2
MSR General Settings
Tx Channels
Adjacent Channels
Gap Channels
Names
Sub Block A
Sub Block B
Sub Block Definition
Center 985.0 MHz
RF Bandwidth 20.0 MHz
Tx Count 2
Tx Channels
Center
Technology
Bandwidth
Weighting Filter
Tx 1 980.0 MHz LTE_10_00 9.015 MHz 0.22
Tx 2 990.0 MHz LTE_10_00 9.015 MHz 0.22
Tx 3 1.96 GHz WCDMA 3.84 MHz 0.22
Tx 4 1.96 GHz WCDMA 3.84 MHz 0.22
Tx 5 1.96 GHz WCDMA 3.84 MHz 0.22
Tx 6 1.96 GHz WCDMA 3.84 MHz 0.22
Tx 7 1.96 GHz WCDMA 3.84 MHz 0.22
Tx 8 1.96 GHz WCDMA 3.84 MHz 0.22

For details on MSR signals see chapter 2.3.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 47.

For details on setting up channels, see chapter 2.3.6.3, "How to Configure an MSR ACLR Measurement", on page 79.

The Tx channel settings for the individual sub blocks are configured in individual subtabs of the "Tx Channel Settings" tab.

Sub Block Definition....69
└ Sub Block Center Frequency....69
└ RF Bandwidth....69
└ Number of Tx Channels (Tx Count)....69
Tx Channel Definition....69
└ Tx Center Frequency....70
└ Technology Used for Transmission....70
└ Tx Channel Bandwidth....70
└ Weighting Filters....71

Sub Block Definition
Sub blocks are groups of transmit channels in an MSR signal. Up to 5 sub blocks can be defined. They are defined as an RF bandwidth around a center frequency with a specific number of transmit channels (max. 18).

Sub blocks are named A,B,C,D,E and are indicated by a slim blue bar along the frequency axis.

Sub Block Center Frequency ← Sub Block Definition
Defines the center of an MSR sub block. Note that the position of the sub block also affects the position of the adjacent gap channels.

Remote command:
`[SENSe:]POWer:ACHannel:SBLock<sb>:FREQuency:CENTer` on page 438

RF Bandwidth ← Sub Block Definition
Defines the bandwidth of the individual MSR sub block. Note that sub block ranges also affect the position of the adjacent gap channels.

Remote command:
`[SENSe:]POWer:ACHannel:SBLock<sb>:RFBWidth` on page 438

Number of Tx Channels (Tx Count) ← Sub Block Definition
Defines the number of transmit channels the specific sub block contains. The maximum is 18 Tx channels.

Remote command:
`[SENSe:]POWer:ACHannel:SBLock<sb>:TXCHannel:COUNt` on page 439

Tx Channel Definition
As opposed to common ACLR channel definitions, the Tx channels are defined at absolute frequencies, rather than by a spacing relative to the (common) center frequency. Each transmit channel can be assigned a different technology, used to predefine the required bandwidth.

The Tx channel settings for the individual sub blocks are configured in individual subtabs of the "Tx Channel Settings" tab.

For details on configuring MSR Tx channels see chapter 2.3.6.3, "How to Configure an MSR ACLR Measurement", on page 79.

Remote command:
[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>] on page 438

Tx Center Frequency ← Tx Channel Definition
Defines the (absolute) center frequency of an MSR Tx channel. Each Tx channel is defined independently of the others; automatic spacing as in common ACLR measurements is not performed.

Note that the position of the first Tx channel in the first sub block and the last Tx channel in the last sub block also affect the position of the adjacent channels.

Remote command:
[SENSe:]POWer:ACHannel:SBLock<sb>:CENTer[:CHANnel<ch>] on page 437

Technology Used for Transmission ← Tx Channel Definition
The technology used for transmission by the individual channel can be defined for each channel. The required channel bandwidth and use of a weighting filter are preconfigured automatically according to the selected technology standard.

"GSM"	Transmission according to GSM standard
"W-CDMA"	Transmission according to W-CDMA standard
"LTE_xxx"	Transmission according to LTE standard for different channel bandwidths
"USER"	User-defined transmission; no automatic preconfiguration possible

Remote command:
[SENSe:]POWer:ACHannel:SBLock<sb>:TECHnology[:CHANnel<ch>] on page 439

Tx Channel Bandwidth ← Tx Channel Definition
The Tx channel bandwidth is normally defined by the transmission technology standard. The correct bandwidth is predefined automatically for the selected technology. Each Tx channel is defined independently of the others; automatic bandwidth configuration for subsequent channels as in common ACLR measurements is not performed.

The bandwidth for each channel is indicated by a colored bar in the display.

Remote command:
[SENSe:]POWer:ACHannel:SBLock<sb>:BANDwidth|BWIDth[:CHANnel<ch>] on page 437

Weighting Filters ← Tx Channel Definition
Weighting filters allow you to determine the influence of individual channels on the total measurement result. For each channel you can activate or deactivate the use of the weighting filter and define an individual weighting factor ("Alpha" value).

Remote command:
Activating/Deactivating:
`[SENSe:]POWer:ACHannel:FILTer:STATe:SBLock<sb>:CHANnel<ch>`
on page 435
Alpha value:
`[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLock<sb>:CHANnel<ch>`
on page 433

2.3.5.3 MSR Adjacent Channel Setup

The "Adjacent Channel" tab in the "MSR ACLR Setup" dialog box provides all the channel settings to configure adjacent and gap channels in MSR ACLR measurements.

For symmetrical channel definition (see "Symmetrical Adjacent Setup" on page 68) the dialog box is reduced as the upper and lower channels are identical.

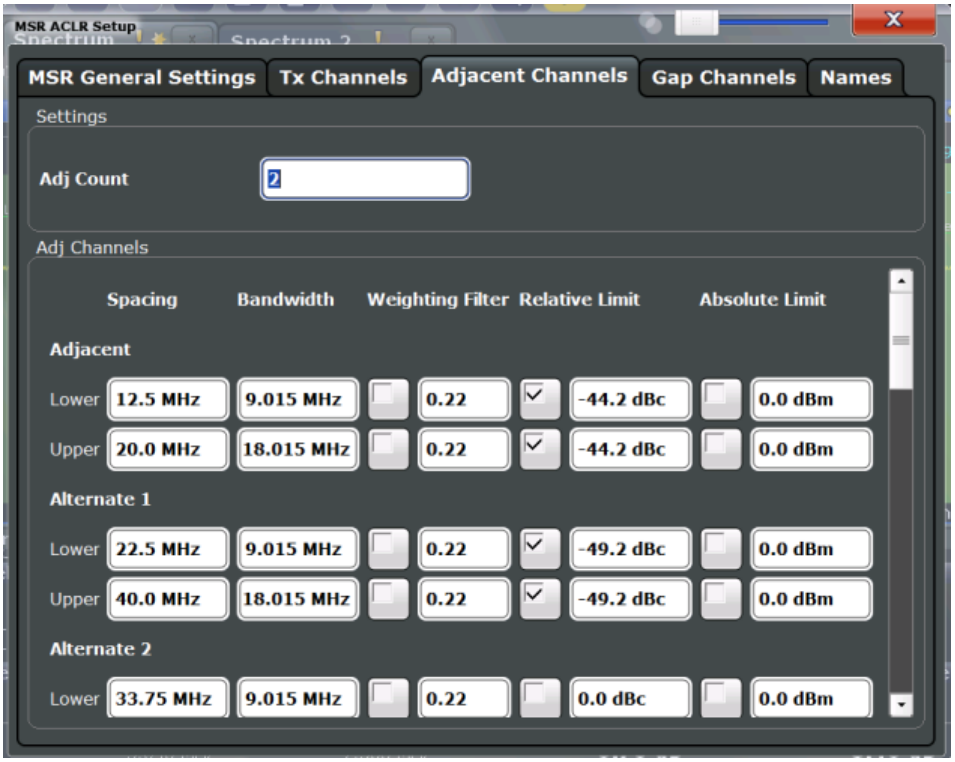


Fig. 2-28: Asymmetrical adjacent channel definition

For details on setting up channels see chapter 2.3.6.3, "How to Configure an MSR ACLR Measurement", on page 79.

Number of Adjacent Channels (ADJ Count)..... 72
Adjacent Channel Definition..... 72
└ Adjacent Channel Spacings..... 72
└ Adjacent Channel Bandwidths..... 73
└ Weighting Filters..... 73
└ Limit Checking..... 73

Number of Adjacent Channels (ADJ Count)
Defines the number of adjacent channels *above and below* the Tx channel block in an MSR signal. The carrier channel to which the relative adjacent-channel power values should be referenced must be defined (see "Reference Channel" on page 55).

Remote command:
`[SENSe:]POWer:ACHannel:ACPairs` on page 414

Adjacent Channel Definition
Defines the channels adjacent to the transmission channel block in MSR signals. A maximum of 12 adjacent channels can be defined.

For MSR signals, adjacent channels are defined in relation to the center frequency of the first and last transmission channel in the entire block, i.e.:

- The lower adjacent channels are defined in relation to the CF of the first Tx channel in the first sub block.
- The upper adjacent channels are defined in relation to the CF of the last Tx channel in the last sub block.

Adjacent channels are named "Adj" and "Alt1" to "Alt11" by default; the names can be changed manually (see chapter 2.3.5.5, "MSR Channel Names", on page 76).

In all other respects, channel definition is identical to common ACLR measurements.

Adjacent Channel Spacings ← Adjacent Channel Definition
Channel spacings are normally predefined by the selected technology but can be changed.

For MSR signals, adjacent channels are defined in relation to the center frequency of the first and last transmission channel in the entire block, i.e.:

- The spacing of the lower adjacent channels refers to the CF of the first Tx channel in the first sub block.
- The spacing of the upper adjacent channels refers to the CF of the last Tx channel in the last sub block.

For details see chapter 2.3.6.3, "How to Configure an MSR ACLR Measurement", on page 79

Remote command:
`[SENSe:]POWer:ACHannel:SPACing[:ACHannel]` on page 416
`[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch>` on page 416
`[SENSe:]POWer:ACHannel:SPACing:UACHannel` on page 440
`[SENSe:]POWer:ACHannel:SPACing:UALTernate<ch>` on page 440

Adjacent Channel Bandwidths ← Adjacent Channel Definition
The adjacent channel bandwidth is normally predefined by the transmission technology standard. The correct bandwidth is set automatically for the selected technology. The bandwidth for each channel is indicated by a colored bar in the display.

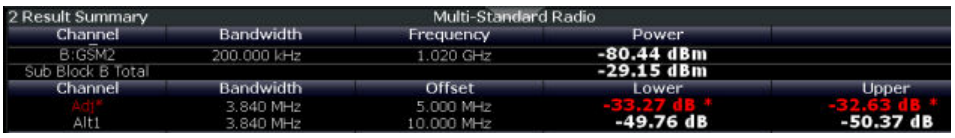
Remote command:
`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ACHannel` on page 414
`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ALTernate<ch>` on page 414
`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:UACHannel` on page 432
`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:UALTernate<ch>` on page 433

Weighting Filters ← Adjacent Channel Definition
Weighting filters allow you to determine the influence of individual channels on the total measurement result. For each channel you can activate or deactivate the use of the weighting filter and define an individual weighting factor ("Alpha" value).

Remote command:
Activating/Deactivating:
`[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel` on page 419
`[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch>` on page 419
`[SENSe:]POWer:ACHannel:FILTer[:STATe]:UACHannel` on page 435
`[SENSe:]POWer:ACHannel:FILTer[:STATe]:UALTernate<ch>` on page 435
Alpha value:
`[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel` on page 418
`[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch>` on page 418
`[SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel` on page 434
`[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch>` on page 434

Limit Checking ← Adjacent Channel Definition
During an ACLR measurement, the power values can be checked whether they exceed user-defined or standard-defined limits. A relative or absolute limit can be defined, or both, for each individual adjacent channel. Both limit types are considered, regardless whether the measured levels are absolute or relative values. The check of both limit values can be activated independently. If any active limit value is exceeded, the measured value is displayed in red and marked by a preceding asterisk in the result table.

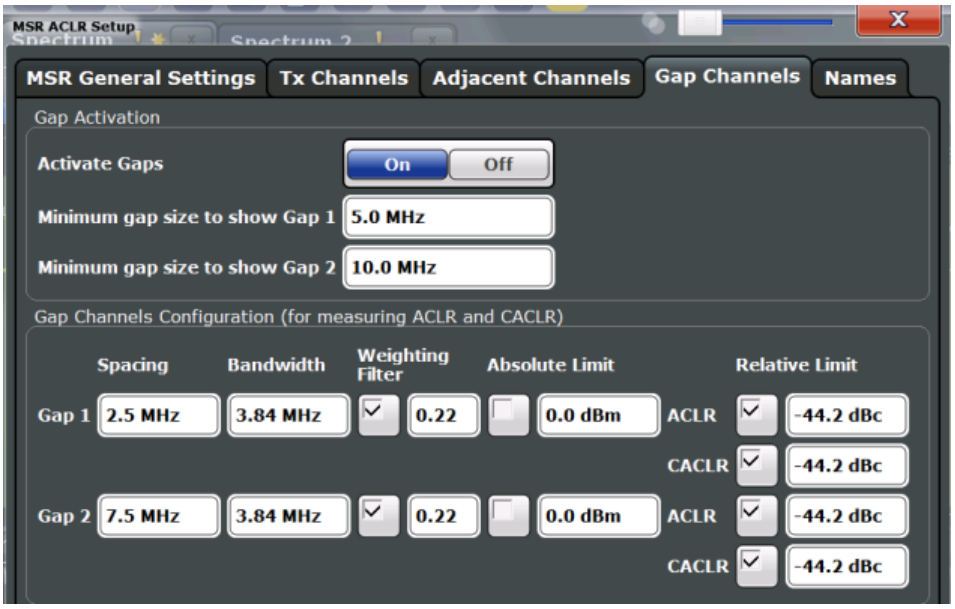
Note that in addition to activating limit checking for individual channels, limit checking must also be activated globally for the MSR ACLR measurement (see "Limit Checking" on page 68).



Remote command:
CALCulate<n>:LIMit<k>:ACPower[:STATe] on page 426
CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute:STATe on page 422
CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute on page 422
CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]:STATe on page 423
CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative] on page 422
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute:STATe on page 424
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute on page 424
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative]:STATe on page 425
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative] on page 425
CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? on page 423

2.3.5.4 MSR Gap Channel Setup

The "Gap Channels" tab in the "MSR ACLR Setup" dialog box provides all the channel settings to configure adjacent and gap channels in MSR ACLR measurements.



For details on MSR signals see chapter 2.3.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 47.

For details on setting up channels see chapter 2.3.6.3, "How to Configure an MSR ACLR Measurement", on page 79.

Activate Gaps....75
Minimum gap size to show gap 1/2....75
Gap Channel Definition....75
└ Gap Channel Spacings....75
└ Gap Channel Bandwidths....76
└ Weighting Filters....76
└ Limit Checking....76

Activate Gaps
If enabled, the gap channels are displayed and channel power results are calculated and displayed in the Result Summary.

Remote command:
`[SENSe:]POWer:ACHannel:AGCHannels` on page 432

Minimum gap size to show gap 1/2
If the gap between the sub blocks does not exceed the specified bandwidth, the gap channels are not displayed in the diagram, and the gap channel results are not calculated in the result summary.

Remote command:
`[SENSe:]POWer:ACHannel:GAP<gap>:MSIZe` on page 435

Gap Channel Definition
Between two sub blocks in an MSR signal, two gaps are defined: a *lower gap* and an *upper gap*. Each gap in turn contains 2 channels, the *gap channels*. The channels in the upper gap are identical to those in the lower gap, but inverted. Thus, in the R&S FSWP MSR ACLR measurement, only 2 gap channels are configured.

Gap channels are indicated by the names of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B), followed by the channel name ("Gap1" or "Gap2") and an "L" (for lower) or a "U" (for upper).

Gap Channel Spacings ← Gap Channel Definition
Gap channel spacings are normally predefined by the MSR standard but can be changed.

Gap channels are defined using bandwidths and spacings, relative to the outer edges of the surrounding sub blocks. Since the upper and lower gap channels are identical, only two channels must be configured. The required spacing can be determined according to the following formula (indicated for lower channels):

Spacing = [CF of the gap channel] - [left sub block center] + ([RF bandwidth of left sub block] /2)

(See also figure 2-25 and figure 2-26.)

For details see chapter 2.3.6.3, "How to Configure an MSR ACLR Measurement", on page 79.

Remote command:
`[SENSe:]POWer:ACHannel:SPACing:GAP<gap>` on page 440

Gap Channel Bandwidths ← Gap Channel Definition
The gap channel bandwidth is normally predefined by the transmission technology standard. The correct bandwidth is set automatically for the selected technology. The bandwidth for each channel is indicated by a colored bar in the display (if the gap is not too narrow, see "Channel display for MSR signals" on page 50).

Remote command:
`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:GAP<gap>` on page 432

Weighting Filters ← Gap Channel Definition
Weighting filters allow you to determine the influence of individual channels on the total measurement result. For each channel you can activate or deactivate the use of the weighting filter and define an individual weighting factor ("Alpha" value).

Remote command:
`[SENSe:]POWer:ACHannel:FILTer:STATe:GAP<gap>` on page 434
`[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>` on page 433

Limit Checking ← Gap Channel Definition
During an ACLR measurement, the power values can be checked whether they exceed user-defined or standard-defined limits. A relative or absolute limit can be defined, or both, for each individual gap channel. Both limit types are considered, regardless whether the measured levels are absolute or relative values. The check of both limit values can be activated independently. Furthermore, relative limits can be defined and activated individually for ACLR or CACLR power levels.

If any active limit value is exceeded, the measured value is displayed in red and marked by a preceding asterisk in the result table.

Note that in addition to activating limit checking for individual channels, limit checking must also be activated globally for the MSR ACLR measurement (see "Limit Checking" on page 68).

Remote command:
`CALCulate<n>:LIMit<k>:ACPower[:STATe]` on page 426
`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute:STATe` on page 429
`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR[:RELative:]STATe` on page 430
`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>[:CACLr][:RELative:]STATe` on page 431
`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute` on page 429
`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR[:RELative]` on page 429
`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>[:CACLr][:RELative]` on page 430
`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RESult?` on page 431

2.3.5.5 MSR Channel Names

Channel names for all TX, adjacent, and alternate channels are user-definable.

In the "Names" tab of the "MSR ACLR Setup" dialog box you can define a customized name for each channel in each sub block. Note that the names are not checked for uniqueness.

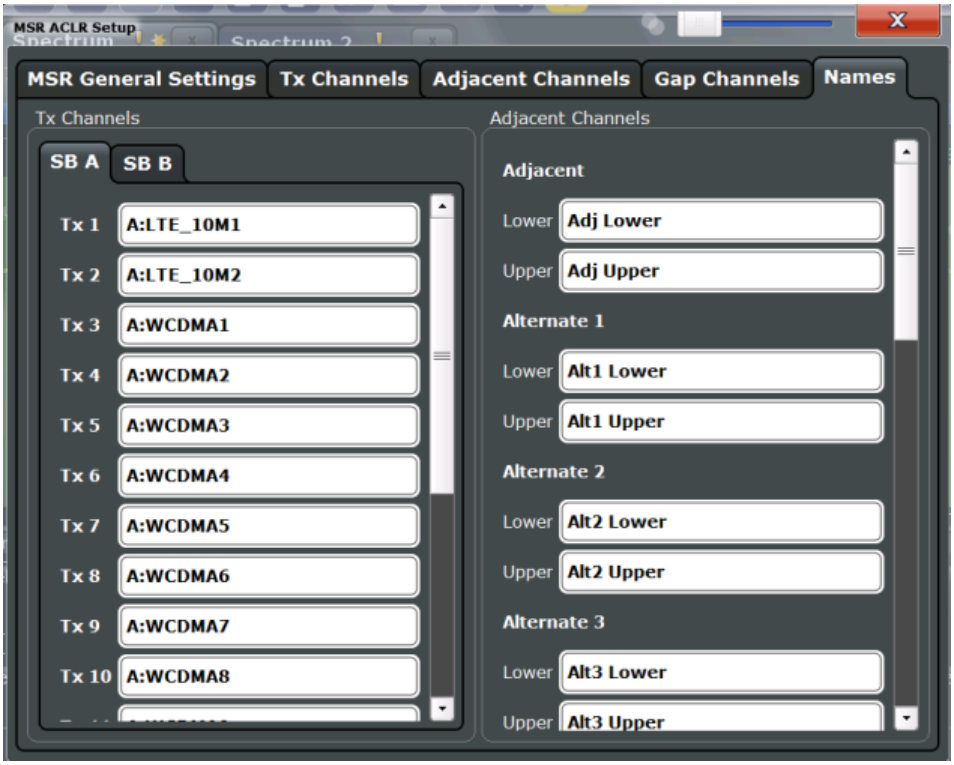


Fig. 2-29: Channel name definition for asymmetric adjacent channels

Remote command:

`[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>]` on page 438

`[SENSe:]POWer:ACHannel:NAME:ACHannel` on page 415

`[SENSe:]POWer:ACHannel:NAME:ALTernate<ch>` on page 415

`[SENSe:]POWer:ACHannel:NAME:UACHannel` on page 436

`[SENSe:]POWer:ACHannel:NAME:UALTernate<ch>` on page 436

2.3.6 How to Perform Channel Power Measurements

The following step-by-step instructions demonstrate the most common tasks when performing channel power measurements.

- How to Perform a Standard Channel Power Measurement....78
- How to Set up the Channels....78
- How to Configure an MSR ACLR Measurement....79
- How to Manage User-Defined Configurations....80
- How to Compare the Tx Channel Power in Successive Measurements....81

2.3.6.1 How to Perform a Standard Channel Power Measurement

Performing a channel power or ACLR measurement according to common standards is a very easy and straightforward task with the R&S FSWP.

1. Press the MEAS key or select "Select Measurement" in the "Overview".
2. Select "Channel Power ACLR".

   The measurement is started immediately with the default settings.
3. Select the "CP / ACLR Standard" softkey and select a standard from the list.

   The measurement is restarted with the predefined settings for the selected standard.
4. If necessary, edit the settings for your specific measurement as described in chapter 2.3.6.2, "How to Set up the Channels", on page 78, or load a user-defined configuration (see "To load a user-defined configuration" on page 81).

2.3.6.2 How to Set up the Channels

Channel definition is the basis for measuring power levels in certain frequency ranges. Usually, the power levels in one or more carrier (Tx) channels and possibly the adjacent channels are of interest. Up to 18 carrier channels and up to 12 adjacent channels can be defined.

When a measurement standard is selected in the "Ch Power" menu or the "ACLR Setup" dialog box, all settings including the channel bandwidths and channel spacings are set according to the selected standard and can be adjusted afterwards.

Channel setup consists of the following settings:

- The number of transmission (Tx) and adjacent channels
- The bandwidth of each channel
- For multicarrier ACLR measurements: which Tx channel is used as a reference
- The spacing between the individual channels
- Optionally: the names of the channels displayed in the diagram and result table
- Optionally: the influence of individual channels on the total measurement result ("Weighting Filter")
- Optionally: limits for a limit check on the measured power levels

Changes to an existing standard can be stored as a user-defined standard, see chapter 2.3.6.4, "How to Manage User-Defined Configurations", on page 80.

► In the "Ch Power" menu, select the "CP / ACLR Config" softkey, then select the "Channel Settings" tab to configure the channels in the "ACLR Setup" dialog box.

In the "Channel Setup" dialog box you can define the channel settings for all channels, independent of the defined number of *used* Tx or adjacent channels.

To define channel spacings

Channel spacings are normally defined by the selected standard but can be changed.

► In the "Channel Settings" tab of the "ACLR Setup" dialog box, select the "Spacing" subtab.
The value entered for any Tx channel is automatically also defined for all subsequent Tx channels. Thus, only one value needs to be entered if all Tx channels have the same spacing.
If the channel spacing for the adjacent or an alternate channel is changed, all higher alternate channel spacings are multiplied by the same factor (new spacing value/old spacing value). The lower adjacent-channel spacings remain unchanged. Only one value needs to be entered for equal channel spacing.

Example: Defining channel spacing

In the default setting, the adjacent channels have the following spacing: 20 kHz ("ADJ"), 40 kHz ("ALT1"), 60 kHz ("ALT2"), 80 kHz ("ALT3"), 100 kHz ("ALT4"), …

If the spacing of the first adjacent channel ("ADJ") is set to 40 kHz, the spacing of all other adjacent channels is multiplied by factor 2 to result in 80 kHz ("ALT1"), 120 kHz ("ALT2"), 160 kHz ("ALT3"), …

If, starting from the default setting, the spacing of the 5th adjacent channel ("ALT4") is set to 150 kHz, the spacing of all higher adjacent channels is multiplied by factor 1.5 to result in 180 kHz ("ALT5"), 210 kHz ("ALT6"), 240 kHz ("ALT7"), …

2.3.6.3 How to Configure an MSR ACLR Measurement

Performing an ACLR measurement on MSR signals is supported by a special configuration with the R&S FSWP.

1. Press the MEAS key or select "Select Measurement" in the "Overview".
2. Select "Channel Power ACLR".
   The measurement is started immediately with the default settings.
3. Select the "CP / ACLR Standard" softkey and select the "Multi-Standard Radio" standard from the list.
4. Select the "CP / ACLR Config" softkey to configure general MSR settings, including the number of sub blocks (up to 5).
   In order to configure asymmetric adjacent channels, deactivate the "Symmetrical" option in the general MSR settings.
5. Select the "Tx Channels" tab to configure the sub blocks and transmission channels.
   For each sub block:

a) Define the (center frequency) position and bandwidth of the sub block, as well as the number of transmission channels it contains.
b) For each transmission channel in the sub block, define the center frequency and select the technology used for transmission. If necessary, edit the bandwidth and define the use of a weighting filter for the channel.

6. Select the "Adjacent Channels" tab to configure the adjacent channels.
7. Define the number of adjacent channels and the settings for each channel:
   - The spacing, defined as the distance of the center frequency from the center frequency of the first transmission channel in the first sub block.
     For asymmetrical channels, define the upper adjacent channel spacing as the distance from the center frequency of the last transmission channel in the last sub block.
   - The bandwidth
   - If necessary, a weighting filter
   - Optionally, define *and activate* relative or absolute limits, or both, against which the power levels of the channel are to be checked.
8. Select the "Gap Channels" tab to configure the gap channels.
9. Define the settings for the two (upper or lower) gap channels; since the upper and lower channels are identical, it is only necessary to configure two channels.
   - The spacing, defined as the distance of the center frequency from the outer edge of the sub block to the left or right of the gap. The required spacing can be determined as follows:
     Spacing = [CF of the gap channel] - [left sub block center] + ([RF bandwidth of left sub block] /2)
   - The bandwidth
   - If necessary, a weighting filter
   - Optionally, define *and activate* relative or absolute limits, or both, against which the power levels of the channel are to be checked.
10. If power limits are defined and activated, activate global limit checking for the measurement on the "MSR General Settings" tab.
11. Optionally, store the settings for the MSR ACLR measurement as a user-defined standard as described in "To store a user-defined configuration" on page 81. Otherwise the configuration will be lost when you select a different measurement standard!

2.3.6.4 How to Manage User-Defined Configurations

You can define measurement configurations independently of a predefined standard and save the current ACLR configuration as a "user standard" in an xml file. You can then load the file and thus the settings again at a later time.

User-defined standards are not supported for "Fast ACLR" and multicarrier ACLR measurements.

Compatibility to R&S FSP

User standards created on an analyzer of the R&S FSP family are compatible to the R&S FSWP. User standards created on an R&S FSWP, however, are not necessarily compatible to the analyzers of the R&S FSP family and may not work there.

To store a user-defined configuration

1. In the "Ch Power" menu, select the "CP / ACLR Config" softkey to display the "ACLR Setup" dialog box.
2. Configure the measurement as required (see also chapter 2.3.6.2, "How to Set up the Channels", on page 78).
3. In the "General Settings" tab, select the "Manage User Standards" button to display the "Manage" dialog box.
4. Define a file name for the user standard and select its storage location.
   By default, the xml file is stored in `C:\R_S\Instr\acp_std\`. However, you can define any other storage location.
5. Select "Save".

To load a user-defined configuration

1. In the "General Settings" tab of the "ACLR Setup" dialog box, select the "Manage User Standards" button to display the "Manage" dialog box.
2. Select the user standard file.
3. Select "Load".

   The stored settings are automatically set on the R&S FSWP and the measurement is restarted with the new parameters.

2.3.6.5 How to Compare the Tx Channel Power in Successive Measurements

For pure channel power measurements, where no adjacent channels and only one Tx channel is defined, you can define a fixed reference power and compare subsequent measurement results to the stored reference power.

1. Configure a measurement with only one Tx channel and no adjacent channels (see also chapter 2.3.6.2, "How to Set up the Channels", on page 78).
2. Select the "Set CP Reference" softkey in the "Ch Power" menu, or the "Set CP Reference" button in the "ACLR Setup" dialog box.

   The channel power currently measured on the Tx channel is stored as a fixed reference power. The reference value is displayed in the "Reference" field of the result table (in relative ACLR mode).
3. Start a new measurement.

   The resulting power is indicated relative to the fixed reference power.

4. Repeat this for any number of measurements.
5. To start a new measurement without the fixed reference, temporarily define a second channel or preset the instrument.

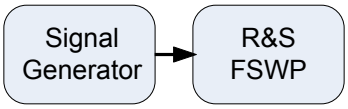
2.3.7 Measurement Examples

The R&S FSWP has test routines for simple channel and adjacent channel power measurements. These routines give quick results without any complex or tedious setting procedures.

- Measurement Example 1 – ACPR Measurement on an CDMA2000 Signal..... 82
- Measurement Example 3 – Measuring the Intrinsic Noise of the R&S FSWP with the Channel Power Function.....83

2.3.7.1 Measurement Example 1 – ACPR Measurement on an CDMA2000 Signal

Test setup:



Signal generator settings (e.g. R&S SMW):

Frequency:	850 MHz
Level:	0 dBm
Modulation:	CDMA2000

Procedure:

1. Preset the R&S FSWP.
2. Set the center frequency to *850 MHz*.
3. Set the span to *4 MHz*.
4. Set the reference level to *+10 dBm*.
5. Select the "Channel Power ACLR" measurement function from the "Select Measurement" dialog box.
6. Set the "CDMA2000 1X" standard for adjacent channel power measurement in the "ACLR Setup" dialog box.

The R&S FSWP sets the channel configuration according to the 2000 standard with 2 adjacent channels above and 2 below the transmit channel. The spectrum is displayed in the upper part of the screen, the numeric values of the results and the channel configuration in the lower part of the screen. The various channels are represented by vertical lines on the graph.
The frequency span, resolution bandwidth, video bandwidth and detector are selected automatically to give correct results. To obtain stable results – especially in the adjacent channels (30 kHz bandwidth) which are narrow in comparison with the transmission channel bandwidth (1.23 MHz) – the RMS detector is used.

7. Set the optimal reference level and RF attenuation for the applied signal level using the "Auto Level" function in the AUTO SET menu.

8. Activate "Fast ACLR" mode in the "ACLR Setup" dialog box to increase the repeatability of results.

   The R&S FSWP sets the optimal RF attenuation and the reference level based on the transmission channel power to obtain the maximum dynamic range. The figure 2-30 shows the result of the measurement.

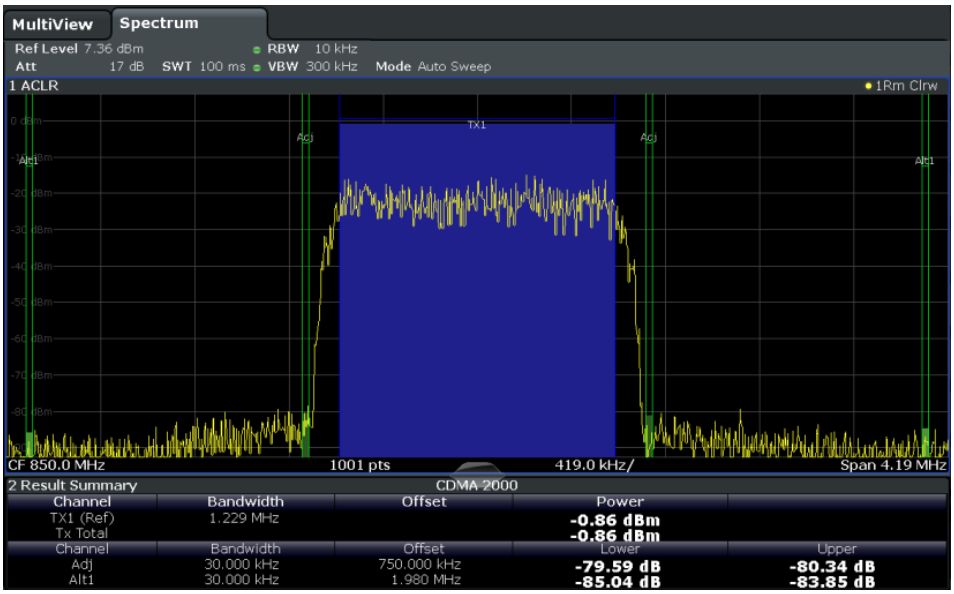


Fig. 2-30: Adjacent channel power measurement on a CDMA2000 1x signal

2.3.7.2 Measurement Example 3 – Measuring the Intrinsic Noise of the R&S FSWP with the Channel Power Function

Noise in any bandwidth can be measured with the channel power measurement functions. Thus the noise power in a communication channel can be determined, for example. If the noise spectrum within the channel bandwidth is flat, the noise marker can be used to determine the noise power in the channel by considering the channel bandwidth. If, however, phase noise and noise that normally increases towards the carrier is dominant in the channel to be measured, or if there are discrete spurious signals in the

channel, the channel power measurement method must be used to obtain correct measurement results.

Test setup:

► Leave the RF input of the R&S FSWP open-circuited or terminate it with 50 Ω.

Procedure:

1. Preset the R&S FSWP.
2. Set the center frequency to *1 GHz* and the span to *1 MHz*.
3. To obtain maximum sensitivity, set RF attenuation to *0 dB* and the reference level to *-40 dBm*.
4. Select the "Channel Power ACLR" measurement function from the "Select Measurement" dialog box.
5. In the "ACLR Setup" dialog box, set up a single Tx channel with the channel bandwidth *1.23 MHz*.
6. Select the "Adjust Settings" softkey.
   The settings for the frequency span, the bandwidth (RBW and VBW) and the detector are automatically set to the optimum values required for the measurement.
7. Stabilize the measurement result by increasing the sweep time.
   Set the sweep time to *1 s*.

   The trace becomes much smoother because of the RMS detector and the channel power measurement display is much more stable.

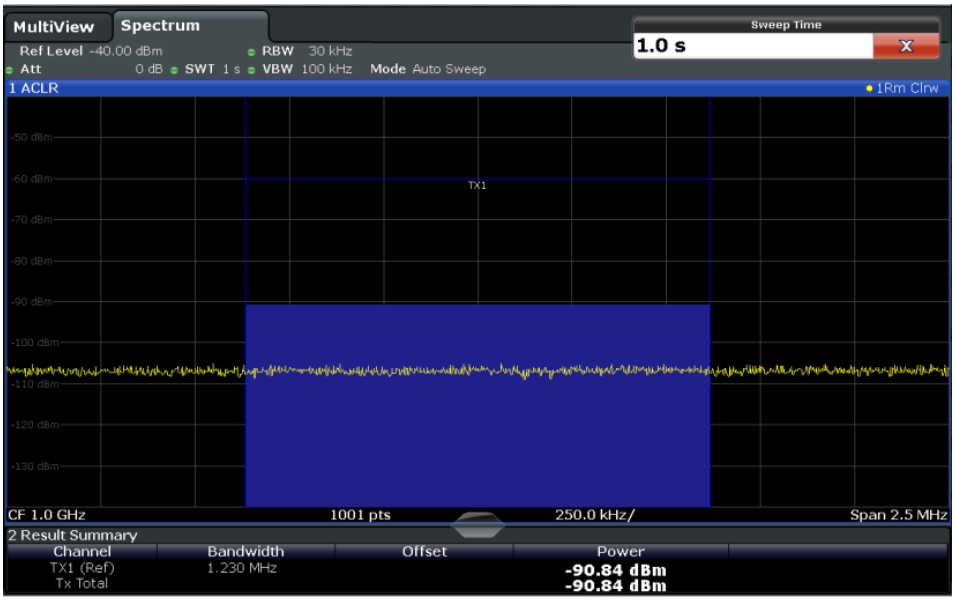


Fig. 2-31: Measurement of the R&S FSWP's intrinsic noise power in a 1.23 MHz channel bandwidth.

2.3.8 Optimizing and Troubleshooting the Measurement

If the results do not meet your expectations, or if you want to minimize the measurement duration, try the following methods to optimize the measurement:

- Only activate as many **adjacent channels** as necessary in order to minimize the required span and thus the required measurement time for the measurement.
- Increase the **RBW** to minimize the measurement time; however, consider the requirements of the standard if you need to measure according to standard! The automatic settings are always according to standard.
- Take advantage of the **speed optimization mode** in the "Sweep" settings if you do not require the larger dynamic range (see "Optimization" on page 266).
- Reduce the **sweep time** and thus the amount of data to be captured and calculated; however, consider the requirements regarding the standard deviation.
- To improve the **stability of the measured results**, increase the sweep time, which also leads to more averaging steps.
- Instead of **trace averaging**, use an RMS detector with a higher sweep time to obtain better average power results in less time.
- To determine a **channel power level** quickly, use the **Time Domain Power Measurement** (TDP) rather than a Channel Power measurement. The TDP measurement is a zero span measurement where the sweep time determines the measurement time. Due to the FFT measurement, duplicate averaging is performed, providing very stable results very quickly.
  Note, however, that for TDP measurements, channel filters are not available and a fixed RBW is used, so that the measurement may not be according to standard for some test cases.

2.3.9 Reference: Predefined CP/ACLR Standards

When using predefined standards for ACLR measurement, the test parameters for the channel and adjacent-channel measurements are configured automatically.

You can select a predefined standard via the "CP / ACLR Standard" softkey in the "Ch Power" menu or the selection list in the "General Settings" tab of the "ACLR Setup" dialog box (see "Standard" on page 53).

Table 2-10: Predefined CP / ACLR standards with remote command parameters

Standard	Remote parameter
None	NONE
Multi-Standard Radio	MSR
EUTRA/LTE Square	EUTRa
EUTRA/LTE Square/RRC	REUTra
W-CDMA 3GPP FWD	FW3Gppcdma
W-CDMA 3GPP REV	RW3Gppcdma
CDMA IS95A FWD	F8CDma
CDMA IS95A REV	R8CDma
CDMA IS95C Class 0 FWD*)	FIS95c0
CDMA IS95C Class 0 REV*)	RIS95c0
CDMA J-STD008 FWD	F19Cdma
CDMA J-STD008 REV	R19Cdma
CDMA IS95C Class 1 FWD*)	FIS95c1
CDMA IS95C Class 1 REV*)	RIS95c1
CDMA2000	S2CDma
TD-SCDMA FWD	FTCDma
TD-SCDMA REV	TRCDma
WLAN 802.11A	AWLAN
WLAN 802.11B	BWLAN
WIMAX	WIMax
WIBRO	WIBRo
GSM	GSM
RFID 14443	RFID14443
TETRA	TETRa
PDC	PDC
PHS	PHS
CDPD	CDPD

Standard	Remote parameter
APCO-25 P2	PAPCo25
User Standard	USER
Customized Standard	<string>

For the R&S FSWP, the channel spacing is defined as the distance between the center frequency of the adjacent channel and the center frequency of the transmission channel. The definition of the adjacent-channel spacing in standards IS95C and CDMA 2000 is different. These standards define the adjacent-channel spacing from the center of the transmission channel to the closest border of the adjacent channel. This definition is also used by the R&S FSWP for the standards marked with an asterisk ***)**.

2.4 Carrier-to-Noise Measurements

The R&S FSWP can easily determine the carrier-to-noise ratio, also normalized to a 1 Hz bandwidth.

- About the Measurement 87
- Carrier-to-Noise Results 88
- Carrier-to-Noise Configuration 89
- How to Determine the Carrier-to-Noise Ratio 90

2.4.1 About the Measurement

The largest signal in the frequency span is the carrier. It is searched when the C/N or C/N_0 function is activated and is marked using a fixed reference marker ("FXD").

To determine the noise power, a channel with a defined bandwidth at the defined center frequency is analyzed. The power within this channel is integrated to obtain the noise power level. (If the carrier is within this channel, an extra step is required to determine the correct noise power level, see below.)

The noise power of the channel is subtracted from the maximum carrier signal level, and in the case of a C/N_0 measurement, it is referred to a 1 Hz bandwidth.

For this measurement, the RMS detector is activated.

The carrier-to-noise measurements are only available in the frequency domain (span >0).

Measurement process

Depending on whether the carrier is inside or outside the analyzed channel, the measurement process for the carrier-to-noise ratio varies:

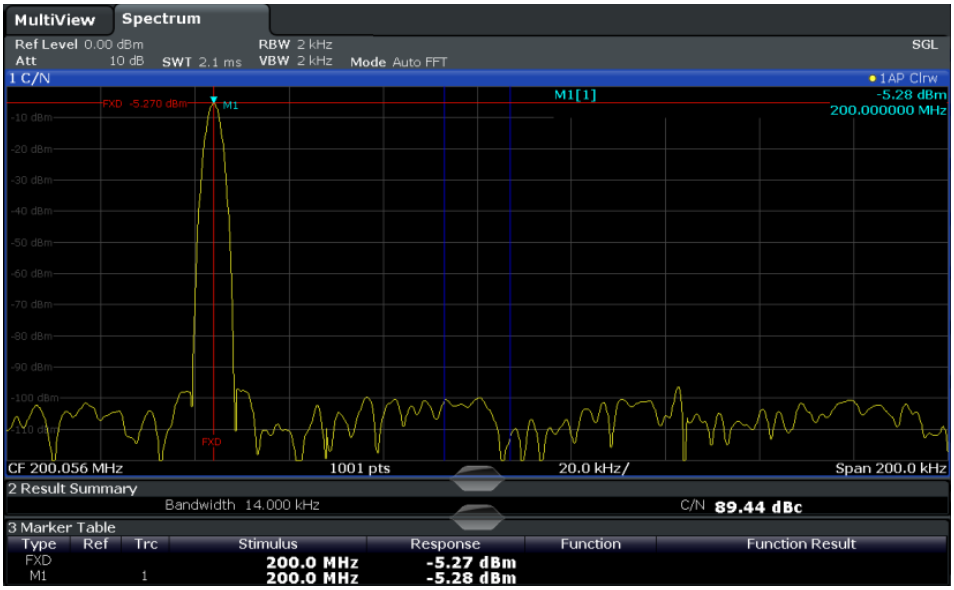
- The carrier is outside the analyzed channel: In this case, it is sufficient to switch on the desired measurement function and to set the channel bandwidth. The carrier/ noise ratio is displayed on the screen.
- The carrier is inside the analyzed channel: In this case, the measurement must be performed in two steps:
  – First, perform the reference measurement by switching on either the C/N or the C/N_0 measurement and waiting for the end of the next measurement run. The fixed reference marker is set to the maximum of the measured carrier signal.
  – Then, switch off the carrier so that only the noise of the test setup is active in the channel. The carrier-to-noise ratio is displayed after the subsequent measurement has been completed.

Frequency Span

The frequency span should be set to approximately 4 times the channel bandwidth in order to measure the carrier-to-noise ratio correctly. This setting is defined automatically by the "Adjust Settings" function.

2.4.2 Carrier-to-Noise Results

As a result of the carrier-to-noise measurement the evaluated bandwidth and the calculated C/N ratio are displayed in the result window. The fixed reference marker is indicated in the diagram.

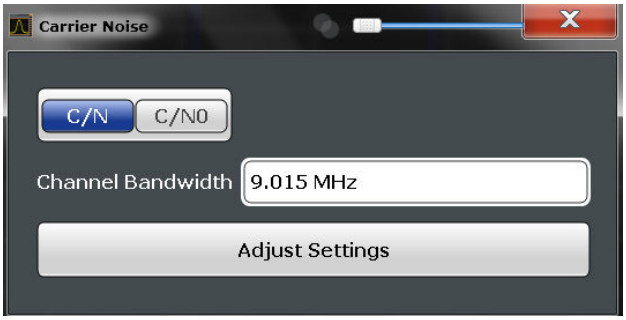


Remote command:

You can also query the determined carrier-to-noise ratio via the remote command `CALC:MARK:FUNC:POW:RES? CN` or `CALC:MARK:FUNC:POW:RES? CN0`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?` on page 408.

2.4.3 Carrier-to-Noise Configuration

The Carrier-to-noise ratio (C/N) and the Carrier-to-noise ratio in relation to the bandwidth (C/N_0) measurements are selected via the corresponding button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Carrier Noise" configuration dialog box, which is displayed as a tab in the "Analysis" dialog box or when you select the "Carrier Noise Config" softkey from the "Carrier Noise" menu.



Carrier-to-noise measurements are not available in zero span mode.

The easiest way to configure a measurement is using the configuration "Overview", see chapter 3.1, "Configuration Overview", on page 193.

The remote commands required to perform these tasks are described in chapter 5.2.5, "Measuring the Carrier-to-Noise Ratio", on page 447.

C/N 89
C/N_0 89
Channel Bandwidth 90
Adjust Settings 90

C/N
Switches the measurement of the carrier/noise ratio on or off. If no marker is active, marker 1 is activated.

The measurement is performed on the trace that marker 1 is assigned to. To shift marker 1 and measure another trace, use the "Marker to Trace" softkey in the "Marker" menu (see "Assigning the Marker to a Trace" on page 361).

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` on page 410
`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?` on page 408
`CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe]` on page 410

C/N_0
Switches the measurement of the carrier/noise ratio with reference to a 1 Hz bandwidth on or off. If no marker is active, marker 1 is activated.

The measurement is performed on the trace that marker 1 is assigned to. To shift marker 1 and measure another trace, use the "Marker to Trace" softkey in the "Marker" menu (see "Assigning the Marker to a Trace" on page 361).

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` on page 410
`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?` on page 408
`CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe]` on page 410

Channel Bandwidth
Defines the measurement channel bandwidth.

The default setting is 14 kHz.

Remote command:
`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>]` on page 415

Adjust Settings
Enables the RMS detector and adjusts the span to the selected channel bandwidth according to:

"4 x channel bandwidth + measurement margin"

The adjustment is performed once; if necessary, the setting can be changed later on.

Remote command:
`[SENSe:]POWer:ACHannel:PRESet` on page 411

2.4.4 How to Determine the Carrier-to-Noise Ratio

1. Press the "C/N, C/N_0" softkey to configure the carrier-to-noise ratio measurement.
2. To change the channel bandwidth to be analyzed, press the "Channel Bandwidth" softkey.
3. To optimize the settings for the selected channel configuration, press the "Adjust Settings" softkey.
4. To activate the measurements without reference to the bandwidth, press the "C/N" softkey.
   To activate the measurements with reference to the bandwidth, press the "C/N_0" softkey .
5. If the carrier signal is located within the analyzed channel bandwidth, switch off the carrier signal so that only the noise is displayed in the channel and perform a second measurement.

   The carrier-to-noise ratio is displayed after the measurement has been completed.

2.5 Occupied Bandwidth Measurement (OBW)

An important characteristic of a modulated signal is its occupied bandwidth. In a radio communications system, for instance, the occupied bandwidth must be limited to enable distortion-free transmission in adjacent channels.

- About the Measurement....91
- OBW Results....93
- OBW Configuration....94
- How to Determine the Occupied Bandwidth....96
- Measurement Example....96

2.5.1 About the Measurement

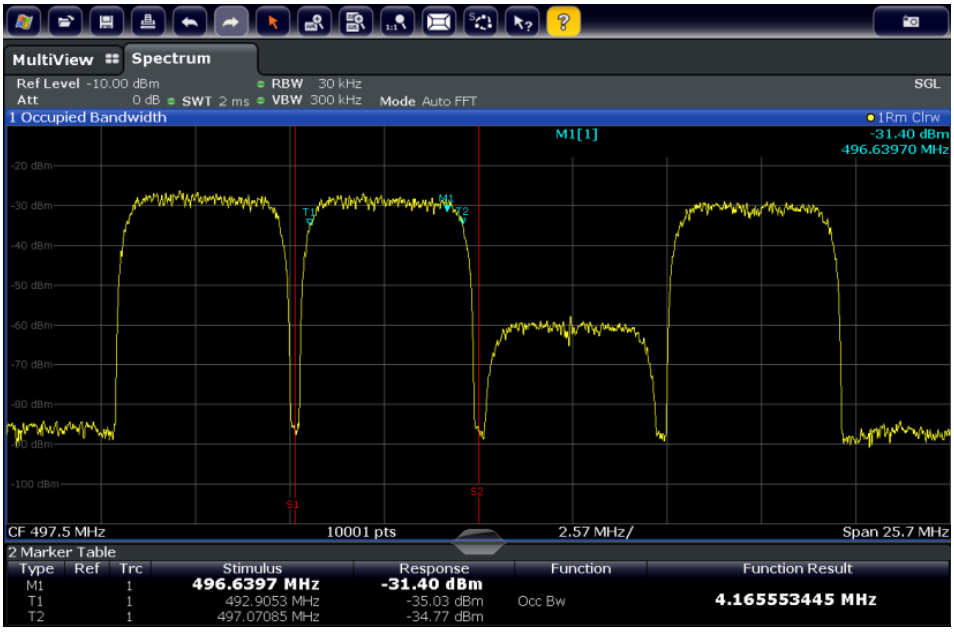
The occupied bandwidth is defined as the bandwidth containing a defined percentage of the total transmitted power. A percentage between 10 % and 99.9 % can be set.

Measurement principle

The bandwidth containing 99% of the signal power is to be determined, for example. The algorithm first calculates the total power of all displayed points of the trace. In the next step, the points from the right edge of the trace are summed up until 0.5 % of the total power is reached. Auxiliary marker 1 is positioned at the corresponding frequency. Then the points from the left edge of the trace are summed up until 0.5 % of the power is reached. Auxiliary marker 2 is positioned at this point. 99 % of the power is now between the two markers. The distance between the two frequency markers is the occupied bandwidth which is displayed in the marker field.

OBW within defined search limits - multicarrier OBW measurement in one sweep

The occupied bandwidth of the signal can also be determined within defined search limits instead of for the entire signal. Thus, only a single sweep is required to determine the OBW for a multicarrier signal. To do so, search limits are defined for an individual carrier and the OBW measurement is restricted to the frequency range contained within those limits. Then the search limits are adapted for the next carrier and the OBW is automatically re-calculated for the new range.



For step-by-step instructions see "How to determine the OBW for a multicarrier signal using search limits" on page 96.

Prerequisites

To ensure correct power measurement, especially for noise signals, and to obtain the correct occupied bandwidth, the following prerequisites and settings are necessary:

- Only the signal to be measured is displayed in the window, or search limits are defined to include only one (carrier) signal. An additional signal would falsify the measurement.
- RBW << occupied bandwidth (approx. 1/20 of occupied bandwidth, for voice communication type: 300 Hz or 1 kHz)
- VBW ≥ 3 x RBW
- RMS detector
- Span ≥ 2 to 3 x occupied bandwidth

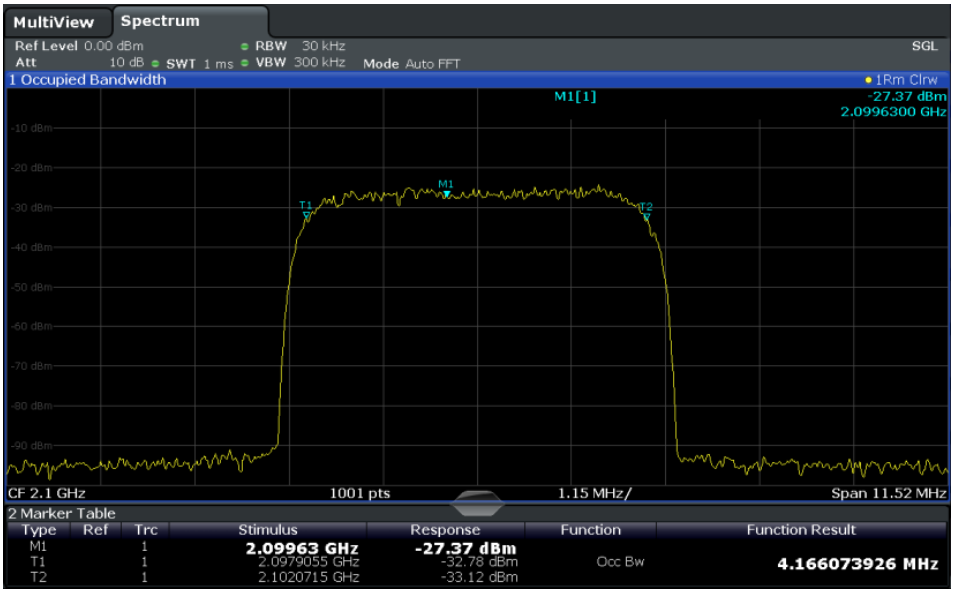
Some of the measurement specifications (e.g. PDC, RCR STD-27B) require measurement of the occupied bandwidth using a peak detector. The detector setting of the R&S FSWP has to be changed accordingly then.

2.5.2 OBW Results

As a result of the OBW measurement the occupied bandwidth ("Occ BW") is indicated in the marker results. Furthermore, the marker at the center frequency and the temporary markers are indicated.

The measurement is performed on the trace with marker 1. In order to evaluate another trace, marker 1 must be placed on another trace (see Assigning the Marker to a Trace).

The OBW calculation is repeated if you change the search limits, without performing a new sweep. Thus, the OBW for a multicarrier signal can be determined using only one sweep.



Remote command:

The determined occupied bandwidth can also be queried using the remote command `CALC:MARK:FUNC:POW:RES? OBW` or `CALC:MARK:FUNC:POW:RES? AOBW`. While the `OBW` parameter returns only the occupied bandwidth, the `AOBW` parameter also returns the position and level of the temporary markers T1 and T2 used to calculate the occupied bandwidth.

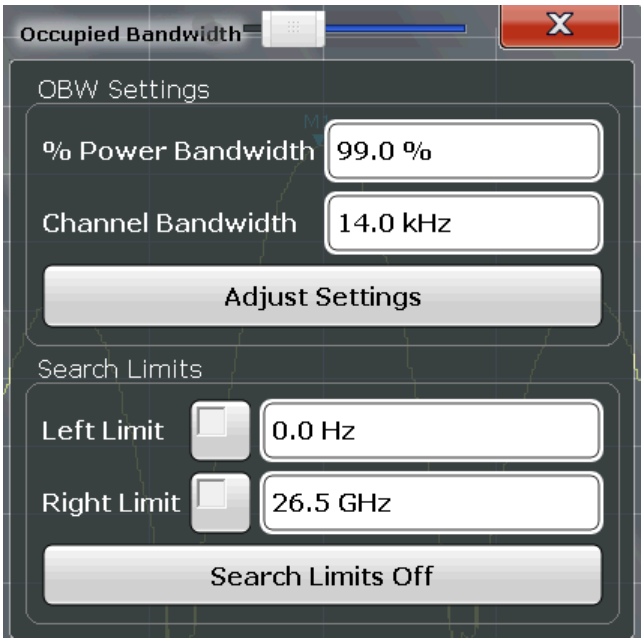
`CALC:MARK:FUNC:POW:SEL OBW`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` on page 410

`CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe]` on page 410

`CALC:MARK:FUNC:POW:RES? OBW`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?` on page 408

2.5.3 OBW Configuration

OBW measurements are selected via the "OBW" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Occupied Bandwidth" dialog box, which is displayed as a tab in the "Analysis" dialog box or when you select the "OBW Config" softkey from the "OBW" menu.



This measurement is not available in zero span.

Configuring search limits for OBW measurement

The OBW measurement uses the same search limits as defined for marker search (see search limits). However, only the left and right limits are considered.

The remote commands required to perform these tasks are described in chapter 5.2.6, "Measuring the Occupied Bandwidth", on page 448.

% Power Bandwidth 94
Channel Bandwidth 95
Adjust Settings 95
Search Limits (Left / Right) 95
Deactivating All Search Limits 95

% Power Bandwidth

Defines the percentage of total power in the displayed frequency range which defines the occupied bandwidth. Values from 10% to 99.9% are allowed.

Remote command:

`[SENSe:]POWer:BANDwidth|BWIDth` on page 449

Channel Bandwidth
Defines the channel bandwidth for the transmission channel in single-carrier measurements. This bandwidth is used to optimize the test parameters (for details see "Adjust Settings" on page 95). The default setting is 14 kHz.

For measurements according to a specific transmission standard, define the bandwidth specified by the standard for the transmission channel.

For multicarrier measurements this setting is irrelevant.

Remote command:
`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>]` on page 415

Adjust Settings
Optimizes the instrument settings for the measurement of the occupied bandwidth according to the specified channel bandwidth.

This function is only useful for single carrier measurements.

All instrument settings relevant for power measurement within a specific frequency range are optimized:

- Frequency span: 3 × channel bandwidth
- RBW ≤ 1/40 of channel bandwidth
- VBW ≥ 3 × RBW
- Detector: RMS

The reference level is not affected by "Adjust Settings". For an optimum dynamic range it should be selected such that the signal maximum is close to the reference level (see "Setting the Reference Level Automatically (Auto Level)" on page 251).

The adjustment is carried out only once. If necessary, the instrument settings can be changed later.

Remote command:
`[SENSe:]POWer:ACHannel:PRESet` on page 411

Search Limits (Left / Right)
If activated, limit lines are defined and displayed for the search. Only results within the limited search range are considered.

For details on limit lines for searches see "Peak search limits" on page 351.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 632
`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 631
`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT` on page 632

Deactivating All Search Limits
Deactivates the search range limits.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 632
`CALCulate<n>:THReshold:STATe` on page 633

2.5.4 How to Determine the Occupied Bandwidth

How to determine the OBW for a single signal

1. Select the "OBW" measurement function from the "Select Measurement" dialog box.
2. Select the "OBW Config" softkey to display the "Occupied Bandwidth" configuration dialog box.
3. Define the percentage of power ("% Power Bandwidth") that defines the bandwidth to be determined.
4. If necessary, change the channel bandwidth for the transmission channel.
5. To optimize the settings for the selected channel configuration, select "Adjust Settings".
6. Start a sweep.

   The result is displayed as OBW in the marker results.

How to determine the OBW for a multicarrier signal using search limits

1. Select the "OBW" measurement function from the "Select Measurement" dialog box.
2. Select the "OBW Config" softkey to display the "Occupied Bandwidth" configuration dialog box.
3. Define the percentage of power ("% Power Bandwidth") that defines the bandwidth to be determined.
4. Define search limits so the search area contains only the first carrier signal:

   a) Enter values for the left or right limits, or both.
   b) Enable the use of the required limits.
5. Start a sweep.

   The result for the first carrier is displayed as OBW in the marker results.
6. Change the search limits so the search area contains the next carrier signal as described in step 4.

   The OBW is re-calculated and the result for the next carrier is displayed. A new sweep is not necessary!
7. Continue in this way until all carriers have been measured.

2.5.5 Measurement Example

In the following example, the bandwidth that occupies 99% of the total power of a PDC signal at 800 MHz, level 0 dBm is measured.

1. Preset the R&S FSWP.
2. Set the center frequency to *800 MHz*.
3. Set the reference level to *-10 dBm*.
4. Select the "OBW" measurement function from the "Select Measurement" dialog box.
5. Set the percentage of power to *99%*.
6. Set the channel bandwidth to *21 kHz* as specified by the PDC standard.
7. Optimize the settings for the selected channel configuration by selecting "Adjust Settings".
8. Adjust the reference level to the measured total power by selecting the "Auto Level" softkey in the AUTO SET menu.
9. The PDC standard requires the peak detector for OBW measurement. In the "Traces" configuration dialog, set the trace detector to "Positive Peak".
10. Start a sweep.

    The result is displayed as OBW in the marker results.

2.6 Spectrum Emission Mask (SEM) Measurement

The R&S FSWP supports Spectrum Emission Mask (SEM) measurements.

- About the Measurement 97
- Typical Applications 98
- SEM Results 98
- SEM Basics 101
- SEM Configuration 111
- How to Perform a Spectrum Emission Mask Measurement 128
- Measurement Example: Multi-SEM Measurement 133
- Reference: SEM File Descriptions 134

2.6.1 About the Measurement

The Spectrum Emission Mask (SEM) measurement defines a measurement that monitors compliance with a spectral mask. The mask is defined with reference to the input signal power. The R&S FSWP allows for a flexible definition of all parameters in the SEM measurement. The analyzer performs measurements in predefined frequency ranges with settings that can be specified individually for each of these ranges.

In the basic Spectrum application, spectrum emissions can be measured for multiple sub blocks of channels, where the sub blocks may include gaps or overlap, and define separate masks. Radio signals using multiple standards can also be analyzed.

SEM measurement configurations can be saved to an xml file which can then be exported to another application or loaded on the R&S FSWP again at a later time. Some predefined XML files are provided that contain ranges and parameters according to the selected standard.

In order to improve the performance of the R&S FSWP for spectrum emission mask measurements, a "Fast SEM" mode is available.

Monitoring compliance of the spectrum is supported by a special limit check for SEM measurements.

2.6.2 Typical Applications

Spectrum Emission Mask measurements are typically performed to ensure that modulated signals remain within the valid signal level ranges defined by a particular transmission standard, both in the transmission channel and neighboring channels. Any violations of the mask may interfere with other transmissions.

The 3GPP TS 34.122 standard, for example, defines a mask for emissions outside the transmission channel. This mask is defined relative to the input signal power. Three frequency ranges to each side of the transmission channel are defined.

2.6.3 SEM Results

As a result of the Spectrum Emission Mask measurement, the measured signal levels, the result of the limit check (mask monitoring) and the defined limit lines are displayed in a diagram (see also chapter 2.6.4.2, "Limit Lines in SEM Measurements", on page 104). Furthermore, the TX channel power "P" is indicated with the used power class.

Multi-SEM measurements

For multi-SEM measurements, that is, SEM measurements with more than one sub block, each sub block has its own power class definitions. In this case, the power class is not indicated in the graphical result displays.

Example:

For example, in figure 2-32, "31 < P < 39" is indicated as the used power class is defined from 31 to 39.

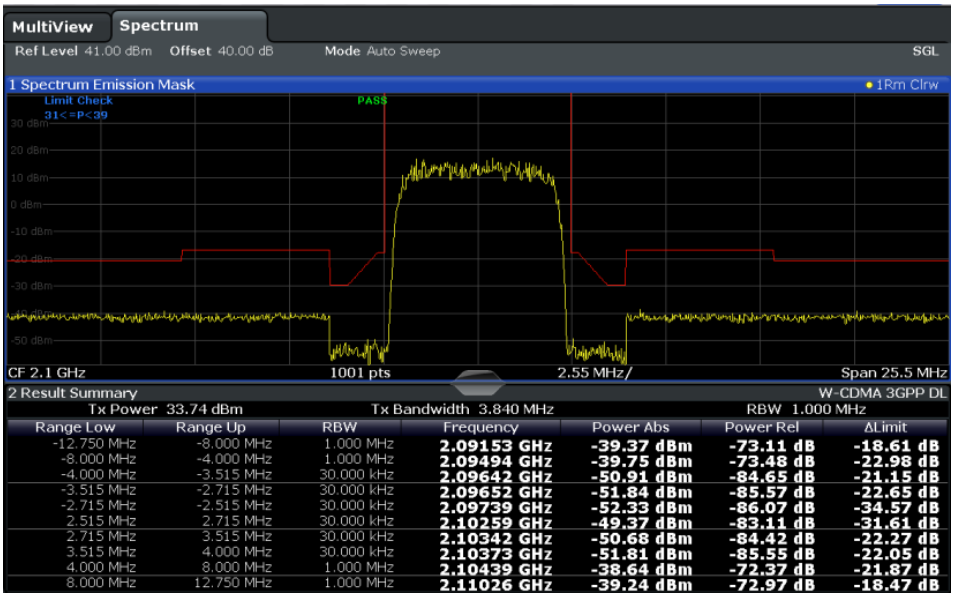

MultiView
Spectrum
Ref Level 41.00 dBm Offset 40.00 dB Mode Auto Sweep SGL
1 Spectrum Emission Mask
1Rm Clrw
Limit Check PASS
31<=P<39
CF 2.1 GHz 1001 pts 2.55 MHz/ Span 25.5 MHz
2 Result Summary
W-CDMA 3GPP DL
Tx Power 33.74 dBm Tx Bandwidth 3.840 MHz RBW 1.000 MHz
Range Low | Range Up | RBW | Frequency | Power Abs | Power Rel | ΔLimit
-12.750 MHz | -8.000 MHz | 1.000 MHz | 2.09153 GHz | -39.37 dBm | -73.11 dB | -18.61 dB
-8.000 MHz | -4.000 MHz | 1.000 MHz | 2.09494 GHz | -39.75 dBm | -73.48 dB | -22.98 dB
-4.000 MHz | -3.515 MHz | 30.000 kHz | 2.09642 GHz | -50.91 dBm | -84.65 dB | -21.15 dB
-3.515 MHz | -2.715 MHz | 30.000 kHz | 2.09652 GHz | -51.84 dBm | -85.57 dB | -22.65 dB
-2.715 MHz | -2.515 MHz | 30.000 kHz | 2.09739 GHz | -52.33 dBm | -86.07 dB | -34.57 dB
2.515 MHz | 2.715 MHz | 30.000 kHz | 2.10259 GHz | -49.37 dBm | -83.11 dB | -31.61 dB
2.715 MHz | 3.515 MHz | 30.000 kHz | 2.10342 GHz | -50.68 dBm | -84.42 dB | -22.27 dB
3.515 MHz | 4.000 MHz | 30.000 kHz | 2.10373 GHz | -51.81 dBm | -85.55 dB | -22.05 dB
4.000 MHz | 8.000 MHz | 1.000 MHz | 2.10439 GHz | -38.64 dBm | -72.37 dB | -21.87 dB
8.000 MHz | 12.750 MHz | 1.000 MHz | 2.11026 GHz | -39.24 dBm | -72.97 dB | -18.47 dB

Fig. 2-32: Spectrum Emission Mask result displays

In addition to the graphical results of the SEM measurement displayed in the diagram, a result summary is displayed to evaluate the limit check results (see also chapter 2.6.4.2, "Limit Lines in SEM Measurements", on page 104).

The following information is provided in the result summary:

Label	Description
General Information	
Standard	Loaded standard settings
Tx Power	Power of the reference range
Tx Bandwidth	Tx bandwidth used by the reference range
RBW	RBW used by the reference range
Range results	
Range Low	Frequency range start the peak value was found in
Range Up	Frequency range end the peak value was found in
RBW	RBW of the range
Frequency	Frequency of the peak power level
Power Abs	Absolute peak power level within the range
Power Rel	Peak power level within the range, relative to the "Tx Power"
ΔLimit	Deviation of the peak power level from the limit line

You can define in which detail the data is displayed in the result summary in the "List Evaluation" settings (see chapter 2.6.5.7, "List Evaluation (Results Configuration)",

on page 127). By default, one peak per range is displayed. However, you can change the settings to display only peaks that exceed a threshold ("Margin").

In addition to listing the peaks in the Result Summary, detected peaks can be indicated by blue squares in the diagram (see Show Peaks in the "List Evaluation" settings).

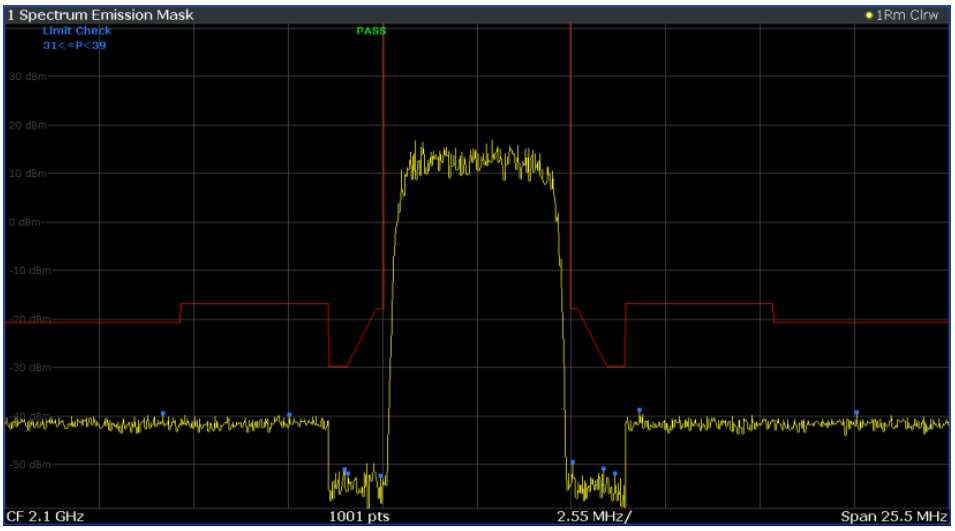


Fig. 2-33: Detected peak display in SEM measurement

Furthermore, you can export the results of the result summary to a file which can be exported to another application for further analysis.

Results for SEM with multiple sub blocks

In the Spectrum application only, spectrum emissions can be measured for multiple sub blocks of channels (see chapter 2.6.4.5, "SEM with Multiple Sub Blocks ("Multi-SEM")", on page 108 for details). Up to three sub blocks (with two gaps) can be defined. For each sub block and each gap, the results described above are provided individually in the result summary.

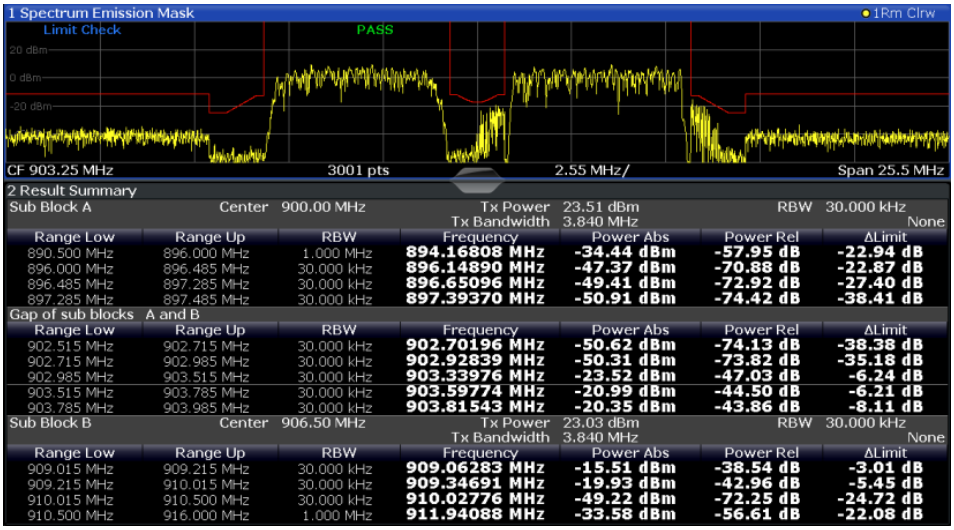

1 Spectrum Emission Mask
1Rm Clrw
Limit Check
PASS
20 dBm
0 dBm
-20 dBm
CF 903.25 MHz
3001 pts
2.55 MHz/
Span 25.5 MHz
2 Result Summary
Sub Block A
Center 900.00 MHz
Tx Power 23.51 dBm
Tx Bandwidth 3.840 MHz
RBW 30.000 kHz
None
Range Low | Range Up | RBW | Frequency | Power Abs | Power Rel | ΔLimit
890.500 MHz | 896.000 MHz | 1.000 MHz | 894.16808 MHz | -34.44 dBm | -57.95 dB | -22.94 dB
896.000 MHz | 896.485 MHz | 30.000 kHz | 896.14890 MHz | -47.37 dBm | -70.88 dB | -22.87 dB
896.485 MHz | 897.285 MHz | 30.000 kHz | 896.65096 MHz | -49.41 dBm | -72.92 dB | -27.40 dB
897.285 MHz | 897.485 MHz | 30.000 kHz | 897.39370 MHz | -50.91 dBm | -74.42 dB | -38.41 dB
Gap of sub blocks A and B
Range Low | Range Up | RBW | Frequency | Power Abs | Power Rel | ΔLimit
902.515 MHz | 902.715 MHz | 30.000 kHz | 902.70196 MHz | -50.62 dBm | -74.13 dB | -38.38 dB
902.715 MHz | 902.985 MHz | 30.000 kHz | 902.92839 MHz | -50.31 dBm | -73.82 dB | -35.18 dB
902.985 MHz | 903.515 MHz | 30.000 kHz | 903.33976 MHz | -23.52 dBm | -47.03 dB | -6.24 dB
903.515 MHz | 903.785 MHz | 30.000 kHz | 903.59774 MHz | -20.99 dBm | -44.50 dB | -6.21 dB
903.785 MHz | 903.985 MHz | 30.000 kHz | 903.81543 MHz | -20.35 dBm | -43.86 dB | -8.11 dB
Sub Block B
Center 906.50 MHz
Tx Power 23.03 dBm
Tx Bandwidth 3.840 MHz
RBW 30.000 kHz
None
Range Low | Range Up | RBW | Frequency | Power Abs | Power Rel | ΔLimit
909.015 MHz | 909.215 MHz | 30.000 kHz | 909.06283 MHz | -15.51 dBm | -38.54 dB | -3.01 dB
909.215 MHz | 910.015 MHz | 30.000 kHz | 909.34691 MHz | -19.93 dBm | -42.96 dB | -5.45 dB
910.015 MHz | 910.500 MHz | 30.000 kHz | 910.02776 MHz | -49.22 dBm | -72.25 dB | -24.72 dB
910.500 MHz | 916.000 MHz | 1.000 MHz | 911.94088 MHz | -33.58 dBm | -56.61 dB | -22.08 dB

Fig. 2-34: SEM results for multiple sub blocks

Retrieving Results via Remote Control

The measurement results of the spectrum emission mask *test* can be retrieved using the `CALC:LIM:FAIL?` command from a remote computer; see `CALCulate<n>:LIMit<k>:FAIL?` on page 665 for a detailed description.

The *power* result for the reference range can be queried using `CALC:MARK:FUNC:POW:RES? CPOW`;

The *peak* power for the reference range can be queried using `CALC:MARK:FUNC:POW:RES? PPOW`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?` on page 408.

The measured power *trace* can be queried using `TRAC:DATA?` and `TRAC:DATA:X?`, see `TRACe<n>[:DATA]` on page 606 and `TRACe<n>[:DATA]:X?` on page 608:

The measured *peak power list* can be queried using `TRAC:DATA? LIST`, see `TRACe<n>[:DATA]` on page 606.

2.6.4 SEM Basics

Some background knowledge on basic terms and principles used in SEM measurements is provided here for a better understanding of the required configuration settings.

- Ranges and Range Settings 102
- Limit Lines in SEM Measurements 104
- Fast SEM Measurements 106
- Multi-Standard Radio (MSR) SEM Measurements 108
- SEM with Multiple Sub Blocks ("Multi-SEM") 108

2.6.4.1 Ranges and Range Settings

In the Spectrum Emission Mask measurements, a range defines a segment for which you can define the following parameters separately:

- Start and stop frequency
- RBW
- VBW
- Sweep time
- Sweep points
- Reference level
- Attenuator settings
- Preamplifier settings
- Transducer settings
- Limit values

Via the sweep list, you define the ranges and their settings. For details on settings refer to chapter 2.6.5.1, "Sweep List", on page 112.

For details on defining the limits (masks) see chapter 2.6.4.2, "Limit Lines in SEM Measurements", on page 104.

For details on defining the limits (masks) see the base unit description "Working with Lines in SEM".

Range definition

After a preset, the sweep list contains a set of default ranges and parameters. For each range, you can change the parameters listed above. You can insert or delete ranges.

The changes of the sweep list are only kept until you load another parameter set (by pressing PRESET or by loading an XML file). If you want a parameter set to be available permanently, create an XML file for this configuration (for details refer to "How to save a user-defined SEM settings file" on page 132).

If you load one of the provided XML files, the sweep list contains ranges and parameters according to the selected standard.

Reference range

The range centered around the center frequency is defined as the reference range for all other ranges in the sweep list. All range limits are defined in relation to the reference range. The TX power used as a reference for all power level results in the result summary is also calculated for this reference range. You can define whether the power used for reference is the peak power level or the integrated power of the reference range. In the "Sweep List", the reference range is highlighted in blue and cannot be deleted.

Rules

The following rules apply to ranges:

- The minimum span of a range is 20 Hz.
- The individual ranges must not overlap (but may have gaps).
- The maximum number of ranges is 30.
- The minimum number of ranges is 3.
- The reference range cannot be deleted.
- The reference range has to be centered on the center frequency.
- The minimum span of the reference range is given by the current "TX Bandwidth" (see "Channel Power Settings" on page 120).
- Frequency values for each range have to be defined relative to the center frequency.

In order to change the start frequency of the first range or the stop frequency of the last range, select the appropriate span with the SPAN key. If you set a span that is smaller than the overall span of the ranges, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz. The first and last ranges are adapted to the given span as long as the minimum span of 20 Hz is not violated.

Sweep points

You can define a minimum number of sweep points for each range. The total number of available sweep points is then distributed among the ranges in consideration of the minimum values. If the total number of sweep points is not enough to satisfy the minimum sweep point requirements in all ranges, the R&S FSWP adjusts the global number of Sweep Points accordingly. By default, each range has a minimum of one sweep point.

This allows you to increase the resolution within a specific range for detailed analysis, without increasing the overall number of sweep points and thus the measurement time for the SEM measurement.

Symmetrical ranges

You can easily define a sweep list with symmetrical range settings, i.e. the ranges to the left and right of the reference range are defined symmetrically. When symmetrical setup is activated, the current sweep list configuration is changed to define a symmetrical setup regarding the reference range. The number of ranges to the left of the reference range is reflected to the right, i.e. any missing ranges on the right are inserted, while superfluous ranges are removed. The values in the ranges to the right of the reference range are adapted symmetrically to those in the left ranges.

Symmetrical ranges fulfill the conditions required for "Fast SEM" mode (see chapter 2.6.4.3, "Fast SEM Measurements", on page 106).

Power classes

If the signal power level to be monitored may vary and the limits will vary accordingly, you can define power classes, which can then be assigned to the frequency ranges. Thus, the limits for the signal levels can be defined differently for varying input levels. For instance, for higher input levels a transmission standard may allow for higher

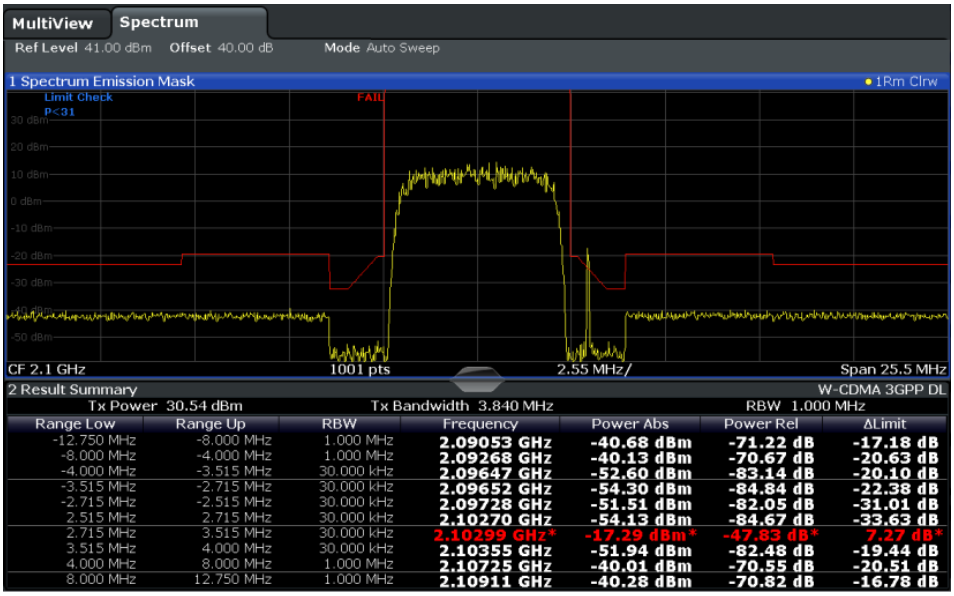
power levels in adjacent channels, whereas for lower input levels the allowed deviation may be stricter. Up to four different power classes can be defined.

2.6.4.2 Limit Lines in SEM Measurements

On the R&S FSWP, the spectrum emission mask is defined using limit lines. Limit lines allow you to check the measured data (that is, the trace results) against specified limit values. Generally, it is possible to define limit lines for any measurement in the Spectrum application using the LINES key. For SEM measurements, however, special limit lines are available via the "Sweep List", and it is strongly recommended that you use only these limit line definitions.

In the "Sweep List" you can define a limit line for each power class that varies its level according to the specified frequency ranges. Special limit lines are automatically defined for each power class according to the current "Sweep List" settings every time the settings change. These limit lines are labeled "_SEM_LINE_<xxx>_ABS<0...3>" and "_SEM_LINE_<xxx>_REL<0...3>", where <xxx> is an index to distinguish limit lines between different measurement channels.

The limit line defined for the currently used power class is indicated by a red line in the display, and the result of the limit check is indicated at the top of the diagram. Note that only "Pass" or "Fail" is indicated; a "margin" function as for general limit lines is not available.



Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-12.750 MHz	-8.000 MHz	1.000 MHz	2.09053 GHz	-40.68 dBm	-71.22 dB	-17.18 dB
-8.000 MHz	-4.000 MHz	1.000 MHz	2.09268 GHz	-40.13 dBm	-70.67 dB	-20.63 dB
-4.000 MHz	-3.515 MHz	30.000 kHz	2.09647 GHz	-52.60 dBm	-83.14 dB	-20.10 dB
-3.515 MHz	-2.715 MHz	30.000 kHz	2.09652 GHz	-54.30 dBm	-84.84 dB	-22.38 dB
-2.715 MHz	-2.515 MHz	30.000 kHz	2.09728 GHz	-51.51 dBm	-82.05 dB	-31.01 dB
2.515 MHz	2.715 MHz	30.000 kHz	2.10270 GHz	-54.13 dBm	-84.67 dB	-33.63 dB
2.715 MHz	3.515 MHz	30.000 kHz	2.10299 GHz*	-17.29 dBm*	-47.83 dB*	7.27 dB*
3.515 MHz	4.000 MHz	30.000 kHz	2.10355 GHz	-51.94 dBm	-82.48 dB	-19.44 dB
4.000 MHz	8.000 MHz	1.000 MHz	2.10725 GHz	-40.01 dBm	-70.55 dB	-20.51 dB
8.000 MHz	12.750 MHz	1.000 MHz	2.10911 GHz	-40.28 dBm	-70.82 dB	-16.78 dB

The indicated limit line depends on the settings in the "Sweep List". Several types of limit checks are possible:

Table 2-11: Limit check types

Limit check type	Pass/fail criteria	Limit line definition
Absolute	Absolute power levels may not exceed limit line	Defined by the "Abs Limit Start"/ "Abs Limit Stop" values for each range
Relative	Power deviations relative to the TX channel power may not exceed limit line	Defined by the "Rel Limit Start"/ "Rel Limit Stop" values (relative to the TX channel power), fixed for each range.
Relative with function f(x)	If the power exceeds **both** the absolute **and** the relative limits, the check fails (see Relative limit line functions below)	Defined by the maximum of the absolute or relative start and stop limit values for each range. Thus, the start or stop point of the limit range, or both, are variable (since the maximum may vary).
Abs and Rel	If the power exceeds **both** the absolute **and** the relative limits, the check fails.	The less strict (higher) limit line is displayed for each range. If you use a function to define the relative limit start or stop value, the signal is checked against an additional condition: the power must exceed the absolute limit, as well as the absolute and relative function values.
Abs or Rel	If the power exceeds **either** the absolute **or** the relative limits, the check fails.	The stricter (lower) limit line is displayed for each range. If you use a function to define the relative limit start or stop value, the signal is checked against an additional condition: if the power exceeds the absolute limit, or the higher of the absolute and relative function values, the check fails.

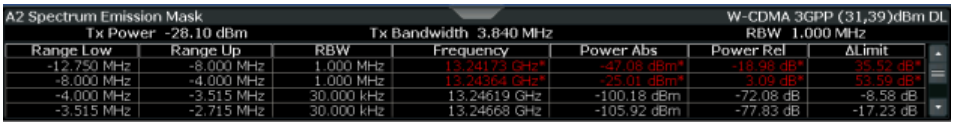
Relative limit line functions

A new function allows you to define limit lines whose start or end points (or both) are variable, depending on the carrier power. Thus, the resulting limit line may change its slope within the range, depending on the carrier power. Common relative limit lines are calculated once for the defined start and end points and maintain a constant slope.

If the relative limit value function is used in combination with the "Abs and Rel" or "Abs or Rel" limit check types, an additional condition is considered for the limit check (see table 2-11).

Limit check results in the result summary

For each range, the peak measured value and the deviation of these values from the limit line are displayed in the result summary. If the limit check is passed for the range, the deviation represents the closest value to the limit line. If the limit check is passed for the range, the deviation represents the closest value to the limit line. If the limit check for the range fails, the deviation represents the maximum violation against the limit line. Furthermore, the absolute power levels and the relative deviation of the peaks from the TX channel power are displayed. Values that exceed the limit are indicated in red and by an asterisk (*).


A2 Spectrum Emission Mask
W-CDMA 3GPP (31,39)dBm DL
Tx Power -28.10 dBm
Tx Bandwidth 3.840 MHz
RBW 1.000 MHz
Range Low | Range Up | RBW | Frequency | Power Abs | Power Rel | ΔLimit
-12.750 MHz | -8.000 MHz | 1.000 MHz | 13.24173 GHz* | -47.08 dBm* | -18.98 dB* | 35.52 dB*
-8.000 MHz | -4.000 MHz | 1.000 MHz | 13.24364 GHz* | -25.01 dBm* | 3.09 dB* | 53.59 dB*
-4.000 MHz | -3.515 MHz | 30.000 kHz | 13.24619 GHz | -100.18 dBm | -72.08 dB | -8.58 dB
-3.515 MHz | -2.715 MHz | 30.000 kHz | 13.24668 GHz | -105.92 dBm | -77.83 dB | -17.23 dB

Although a margin functionality is not available for the limit check, a margin (threshold) for the peak values to be displayed in the Result Summary can be defined in the "List Evaluation" settings. For details see chapter 2.6.5.7, "List Evaluation (Results Configuration)", on page 127.

2.6.4.3 Fast SEM Measurements

In order to improve the performance of the R&S FSWP for spectrum emission mask measurements, a "Fast SEM" mode is available. If this mode is activated, several consecutive ranges with identical sweep settings are combined to one sweep internally, which makes the measurement considerably faster. The displayed results remain unchanged and still consist of several ranges. Thus, measurement settings that apply only to the results, such as limits or transducer factors, can nevertheless be defined individually for each range.

Prerequisites

"Fast SEM" mode is available if the following criteria apply:

- The frequency ranges are consecutive, without frequency gaps
- The following sweep settings are identical (for details see chapter 2.6.5.1, "Sweep List", on page 112):
  - Filter Type
  - RBW
  - VBW
  - Sweep Time Mode
  - Reference Level
  - Rf Attenuation Mode
  - RF Attenuation
  - Preamplification

Activating Fast SEM mode

"Fast SEM" mode is activated in the sweep list (see chapter 2.6.5.1, "Sweep List", on page 112) or using a remote command. Activating the mode for one range automatically activates it for all ranges in the sweep list.

Remote command:

`[SENSe:]ESPectrum<sb>:HighSPeed` on page 454

Fast SEM not supported for multiple sub blocks

For SEM with multiple sub blocks, fast SEM is not available. If more than 1 sub block is defined and a standard is loaded which contains an active fast SEM setting, this setting is disabled.

For more information on multi-SEM measurements see chapter 2.6.4.5, "SEM with Multiple Sub Blocks ("Multi-SEM")", on page 108.

Consequences

When the "Fast SEM" mode is activated, the ranges for which these criteria apply are displayed as one single range. The sweep time is defined as the sum of the individual sweep times, initially, but can be changed.

If "Symmetrical Setup" mode is active when "Fast SEM" mode is activated, not all sweep list settings can be configured symmetrically automatically (see also "Symmetric Setup" on page 118).

Any other changes to the sweep settings of the combined range are applied to each included range and remain changed even after deactivating "Fast SEM" mode.

Example

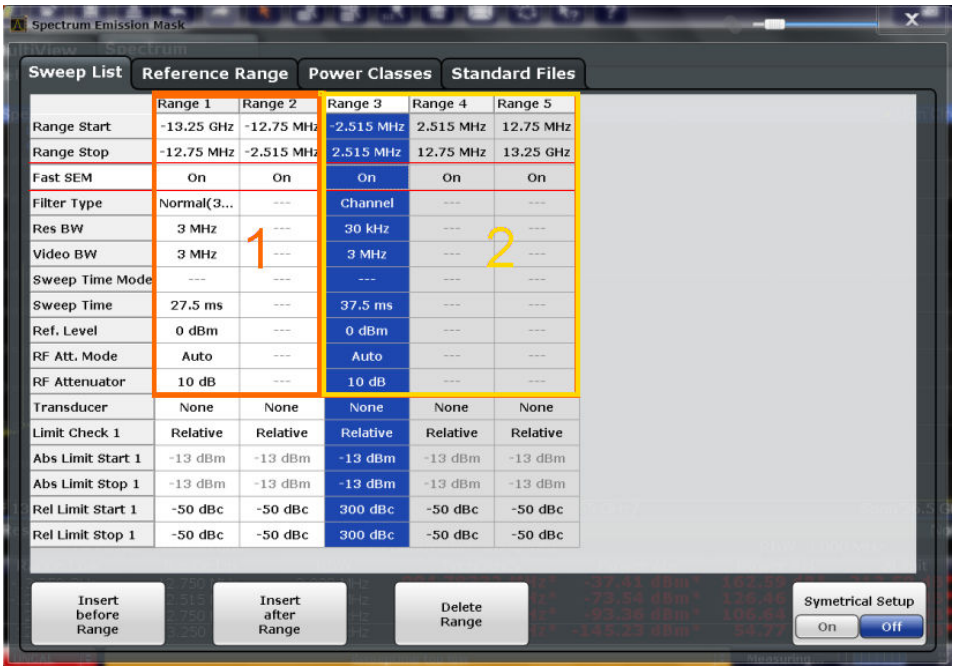


Fig. 2-35: Sweep list using Fast SEM mode

In figure 2-35, a sweep list is shown for which Fast SEM is activated. The formerly 5 separately defined ranges are combined to 2 sweep ranges internally.

2.6.4.4 Multi-Standard Radio (MSR) SEM Measurements

Multi-standard radio (MSR) measurements allow you to perform SEM tests on signals with multiple carriers using different digital standards. MSR measurements are described in the specification 3GPP TS 37.141. Various typical combinations of standards for base station tests are described, e.g. LTE FDD and W-CDMA carriers. By performing an MSR SEM measurement you can determine if or how the different carriers affect each other, i.e. if unwanted emissions occur. On the R&S FSWP, the MSR SEM measurement is a standard measurement as for single carriers. The MSR settings merely provide a convenient way of configuring the sweep list for all required ranges according to the specification very quickly.

Refined settings allow the R&S FSWP to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0, which distinguishes between base station configurations and power values.

2.6.4.5 SEM with Multiple Sub Blocks ("Multi-SEM")

In the Spectrum application only, spectrum emissions can be measured for multiple sub blocks of channels (also referred to as a "Multi-SEM" measurement). Sub blocks are a set of multiple ranges around a defined center frequency (carrier). Multiple sub blocks may include gaps or overlap, and each sub block defines a separate mask. The behavior in the overlapping masks is defined by multi-limit line calculation. Up to three sub blocks (with two gaps) can be defined. For each sub block, the familiar configuration settings concerning ranges, limit lines and MSR can be defined individually.

Comparison to "traditional" SEM measurement

The default SEM measurement is simply a special case of "*Multi-SEM*" - consisting of one single block. Only when you define a number of sub blocks larger than 1 in the basic SEM configuration, multiple sub blocks are inserted in the configuration settings and result tables.

Particular features of configuring multiple sub blocks

The sub blocks are independent of the global start, stop, center and span frequencies for the complete SEM measurement. Thus, there can be gaps that may even include other carrier ranges, but are not configured for the SEM measurement.

For each sub block, you define:

- the center frequency of the reference range of the sub block; center frequencies must be defined in ascending order for sub blocks A,B,C
- the reference range; note that although individual ranges of different sub blocks may overlap, reference ranges for different sub blocks may *not*; they must define distinct frequency ranges
- the sweep list, including the limit lines
- optionally: a standard file *or* MSR settings to be used for measurement (if one is selected, the other is disabled)

Fast SEM not supported for multiple sub blocks

For SEM with multiple sub blocks, fast SEM is not available. If more than 1 sub block is defined and a standard is loaded which contains an active fast SEM setting, this setting is disabled.

Absolute vs relative frequencies

In the default configuration with only 1 sub block, frequencies are defined relative to the center frequency; this is the familiar configuration.

For setups with more than 1 sub block, frequencies are defined relative to the center frequency of the reference ranges for the individual sub blocks. However, in the result summary, frequencies are indicated as absolute values. Relative frequencies that refer to different reference ranges would be inconvenient and difficult to analyze.

Limit check behavior for overlapping masks

Since spectrum emission masks are defined individually for each sub block, and sub blocks may overlap, the question arises what happens during the limit check in the overlapping regions? To answer this question we must distinguish the following cases:

- For the reference range, no limit checking is performed, as the reference range contains the carrier
- For other ranges, only the limit lines defined for ranges between the carriers, that is the reference ranges, to either side are significant. In other words, if a limit line definition covers the frequency area of several carriers, only the limit lines for ranges between the corresponding reference range and the next closest reference range are significant.

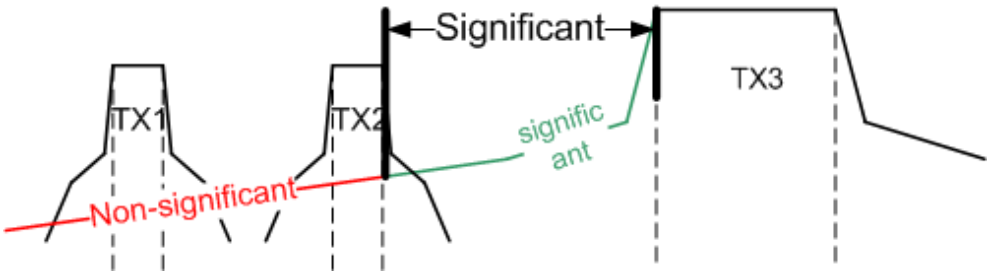


Fig. 2-36: Behavior for overlapping masks

- For these ranges, in which multiple limit lines are significant, a range-specific function determines the behavior of the limit check

Limit calculation for individual ranges

For each range a function can be defined that determines the behavior of the limit check in case of multiple limit lines:

- **"NONE"**: In reference ranges no limit check is performed;
  Reference ranges always use the function "NONE".
  For other ranges, see the combinations for overlapping ranges below.
- **"SUM"**: sum of the two limit lines (calculated for linear powers) is used
- **"MAX"**: maximum of the two limit lines is used

This leads to the following **combinations for overlapping ranges**:

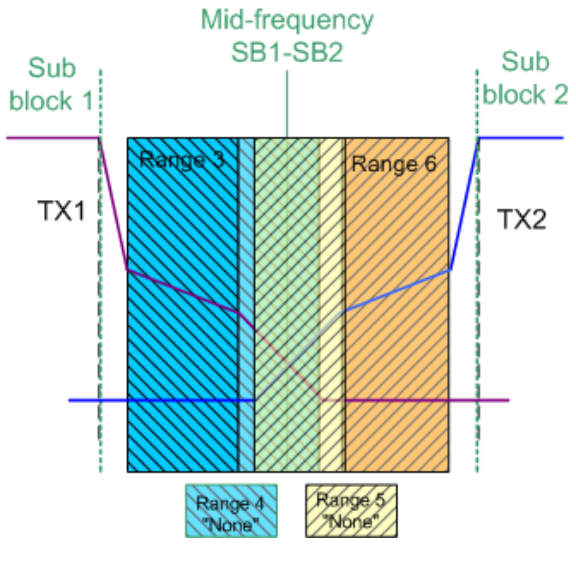
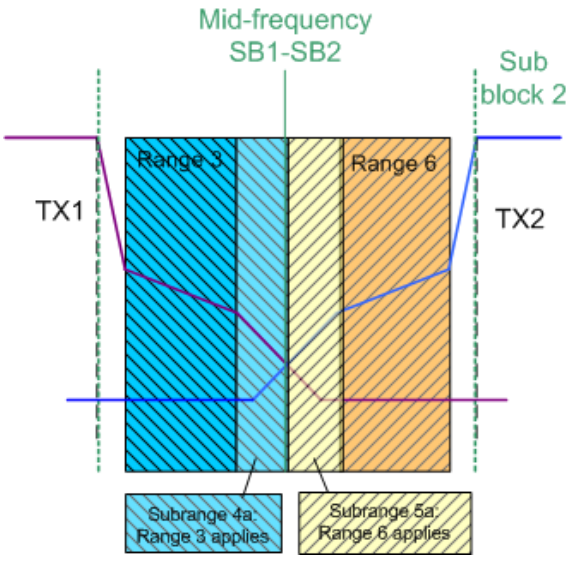
- **"MAX+MAX"**: maximum of the two limit lines is used
- **"MAX+SUM"**: maximum of the two limit lines is used
- **"SUM+SUM"**: sum of the two limit lines (calculated for linear powers) is used
- **"NONE+MAX"/"NONE+SUM"**: limit line (and parameters) of the "NONE" range are ignored
- **"NONE+NONE"**: depends on the position of the overlapping ranges in relation to the mid-frequency between the two neighboring sub blocks:
  - overlap is completely *below* the mid-frequency: limits and parameters of the left sub block are used
  - overlap is completely *above* the mid-frequency: limits and parameters of the right sub block are used
  - overlap crosses the mid-frequency: new subranges are created: one to the left of the mid-frequency, one to the right of the mid-frequency. The left subrange uses the limits and parameters of the left sub block, the right subrange uses the limits and parameters of the right sub block.

Different RBWs in overlapping ranges

If different RBWs are defined for the overlapping ranges, the RBW, as well as the VBW, attenuation, reference level, transducer, filter type and (proportional) sweep time of the range with the smaller RBW are considered for both ranges. In the range with the higher RBW, the following offset is applied to the limit line:

$-10*log(RBW_{large} / RBW_{small})$

Table 2-12: Limit lines in overlapping ranges crossing the mid-frequency

	
Initial situation: overlapping ranges Range 4 ("None") + Range 5 ("None") overlap and cross the mid-frequency between sub blocks 1 and 2	**Result:** Subranges 4a and 5a are created left and right of the mid-frequency; For subrange 4a: limit line and parameters of range 4 apply For subrange 5a: limit line and parameters of range 5 apply

Global SEM limit check

For the complete SEM measurement, which may consist of multiple sub blocks, only one single limit check is performed. A single limit line is calculated according to the individual range limit lines and the defined functions for overlapping ranges. The measured values are then compared with this single limit line. If the limit is exceeded in any range, the result of the limit check is "failed".

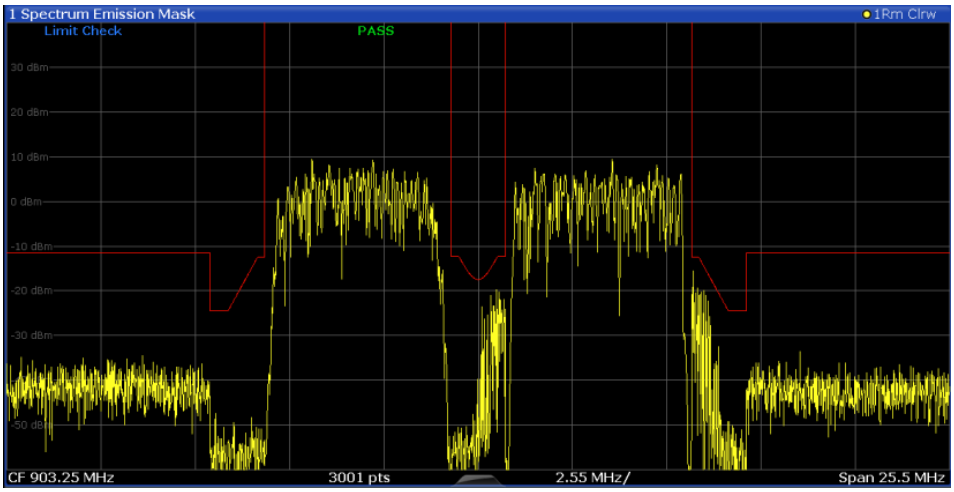


Fig. 2-37: Summarized limit line for multiple sub blocks

2.6.5 SEM Configuration

SEM measurements are selected via the "Spectrum Emission Mask" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Spectrum Emission Mask" configuration dialog box, which is displayed when you select the "SEM Setup" button in the "Overview" or one of the softkeys from the "SEMask" menu.

The remote commands required to perform these tasks are described in chapter 5.2.7, "Measuring with Spectrum Emission Masks", on page 450.

Global span settings

The span of the signal to be monitored is configured in the general span settings (see chapter 3.3.2, "Frequency and Span Settings", on page 240). Only ranges within this global span are considered for the SEM measurement.

Multi-SEM configuration

In the Spectrum application only, spectrum emissions can be measured for multiple sub blocks of channels (see chapter 2.6.4.5, "SEM with Multiple Sub Blocks ("Multi-SEM")", on page 108). Up to three sub blocks (with two gaps) can be defined. For each sub block, the familiar configuration settings concerning ranges, limit lines and MSR can be defined in individual tabs. In addition, settings on the sub blocks themselves must be configured in the "Sub Blocks" tab of the "Spectrum Emission Mask" configuration dialog box (see chapter 2.6.5.2, "Multi-SEM (Sub Block) Settings ", on page 118).

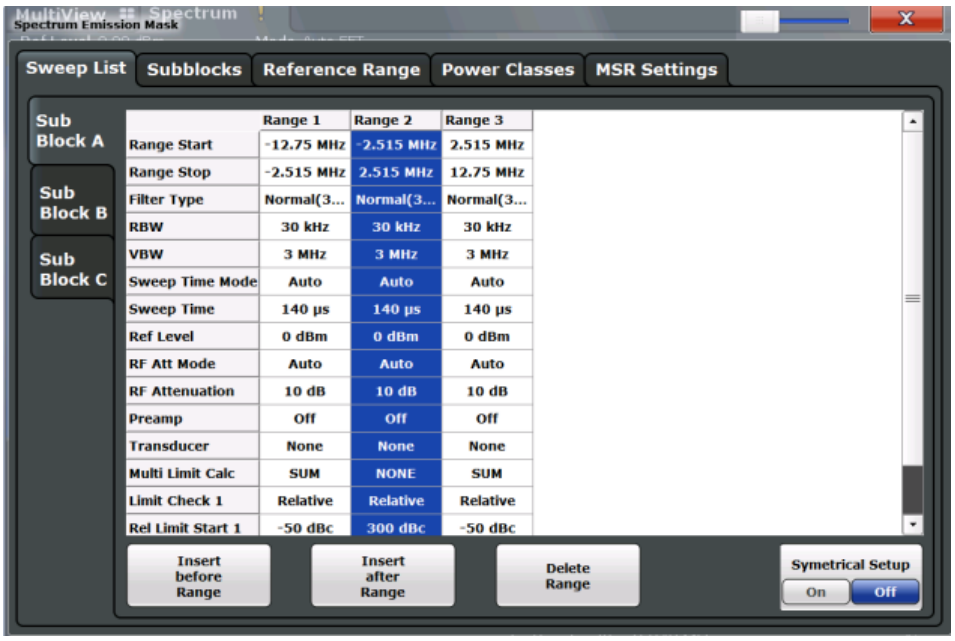
The following settings are available in individual tabs of the "Spectrum Emission Mask" configuration dialog box.

- Sweep List....112
- Multi-SEM (Sub Block) Settings....118
- Reference Range....119
- Power Classes....121
- MSR Settings....122
- Standard Files....125
- List Evaluation (Results Configuration)....127

2.6.5.1 Sweep List

For SEM measurements, the input signal is split into several frequency ranges which are swept individually and for which different limitations apply. In the "Sweep List" tab of the "Spectrum Emission Mask" dialog box you configure the individual frequency ranges and mask limits.

If you edit the sweep list, always follow the rules and consider the limitations described in chapter 2.6.4.1, "Ranges and Range Settings", on page 102.



Range Start / Range Stop....113
Fast SEM....114
Filter Type....114
RBW....114
VBW....114
Sweep Time Mode....114
Sweep Time....115
Ref. Level....115
RF Att. Mode....115
RF Attenuator....115
Preamp....115
Transd. Factor....115
Limit Check <n>....116
Abs Limit Start/Stop <n>....116
Rel Limit Start/Stop <n>....116
Multi-Limit Calc <n>....117
Minimum Sweep Points....117
Insert before/after Range....117
Delete Range....118
Symmetric Setup....118

Range Start / Range Stop

Sets the start frequency/stop frequency of the selected range.

In order to change the start/stop frequency of the first or last range, respectively, select the appropriate span with the SPAN key. If you set a span that is smaller than the overall span of the ranges, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz. The first and last ranges are adapted to the given span as long as the minimum span of 20 Hz is not violated.

Frequency values for each range have to be defined relative to the center frequency. The reference range has to be centered on the center frequency. The minimum span of the reference range is given by the current "TX Bandwidth" (see "Channel Power Settings" on page 120).

Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<range>[:FREQuency]:STARt` on page 456
`[SENSe:]ESPectrum<sb>:RANGe<range>[:FREQuency]:STOP` on page 457

Fast SEM
Activates "Fast SEM" mode for all ranges in the sweep list. For details see chapter 2.6.4.3, "Fast SEM Measurements", on page 106.

Note: If you deactivate "Fast SEM" mode while "Symmetrical Setup" mode is on, "Symmetrical Setup" mode is automatically also deactivated.
If you activate "Fast SEM" mode while "Symmetrical Setup" mode is on, not all range settings can be configured symmetrically automatically.

Remote command:
`[SENSe:]ESPectrum<sb>:HighSPeed` on page 454

Filter Type
Sets the filter type for this range.

For details on filter types see chapter 3.5.1.6, "Which Data May Pass: Filter Types", on page 259.

Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<range>:FILTer:TYPE` on page 456

RBW
Sets the resolution bandwidth for this range.

For details on the RBW see chapter 3.5.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth", on page 256.

Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<range>:BANDwidth[:RESolution]`
on page 455

VBW
Sets the video bandwidth for this range.

For details on the VBW see chapter 3.5.1.2, "Smoothing the Trace Using the Video Bandwidth", on page 256.

Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<range>:BANDwidth:VIDeo` on page 455

Sweep Time Mode
Activates or deactivates the auto mode for the sweep time.

For details on the sweep time mode see chapter 3.5.1.7, "How Long the Data is Measured: Sweep Time", on page 259

Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<range>:SWEep:TIME:AUTO` on page 466

Sweep Time
Sets the sweep time value for the range.

For details on the sweep time see chapter 3.5.1.7, "How Long the Data is Measured: Sweep Time", on page 259

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<range>:SWEep:TIME on page 466

Ref. Level
Sets the reference level for the range.

For details on the reference level see chapter 3.4.1.1, "Reference Level", on page 247.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<range>:RLEVel on page 466

RF Att. Mode
Activates or deactivates the auto mode for RF attenuation.

For details on attenuation see chapter 3.4.1.2, "RF Attenuation", on page 248.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:ATTenuation:AUTO on page 458

RF Attenuator
Sets the attenuation value for the range.

For details on attenuation see chapter 3.4.1.3, "Scaling", on page 249.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:ATTenuation on page 457

Preamp
Switches the preamplifier on or off.

For details on the preamplifier see "Preamplifier" on page 252.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:GAIN:STATe on page 459

Transd. Factor
Sets a transducer for the specified range. You can only choose a transducer that fulfills the following conditions:

- The transducer overlaps or equals the span of the range.
- The x-axis is linear.
- The unit is dB.

For details on transducers see chapter 3.8.1, "Basics on Transducer Factors", on page 291.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<range>:TRANsducer on page 467

Limit Check <n>
Sets the type of limit check for the n-th power class in the range. Up to four limits are possible.

For details on limit checks see chapter 2.6.4.2, "Limit Lines in SEM Measurements", on page 104.

The limit state affects the availability of all limit settings.

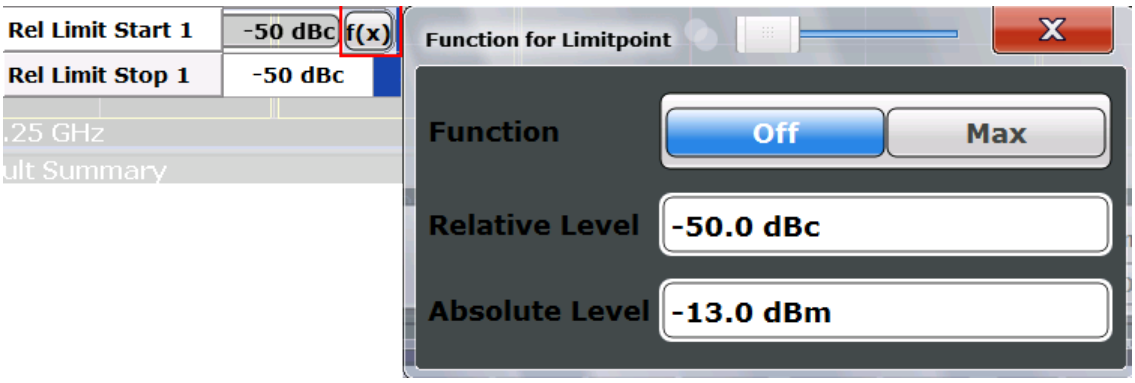
Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:STATe` on page 464
`CALCulate<n>:LIMit<k>:FAIL?` on page 665

Abs Limit Start/Stop <n>
Sets an absolute limit value for the n-th power class at the start or stop frequency of the range [dBm].

Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:STARt` on page 459
`[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:STOP` on page 460

Rel Limit Start/Stop <n>
Sets a relative limit value for the n-th power class at the start or stop frequency of the range [dBc].

By default, this value is a fixed relative limit, i.e. no function is defined. To define a function for the relative limit, select the input field for "Rel Limit Start" or "Rel Limit Stop" and then the "f(x)" icon that appears.



If the function is set to "MAX", you can define a relative *and* an absolute limit level. In this case, the maximum of the two values is used as the limit level.

For more information see "Relative limit line functions" on page 105.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt on page 461
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP on page 462
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt:FUNCtion on page 462
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:FUNCtion on page 464
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt:ABS on page 461
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:ABSolute on page 463

Multi-Limit Calc <n>
Defines the function used to calculate the limit line for the n-th power class for overlapping ranges in Multi-SEM measurements. For details see "Limit calculation for individual ranges" on page 109.

"NONE" (reference ranges only:) the limit of the reference range is used
"SUM" sum of the two limit lines (calculated for linear powers) is used
"MAX" maximum of the two limit lines is used

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<range>:MLCalc on page 452

Minimum Sweep Points
Defines the minimum number of sweep points for the range.

If necessary to fulfill all minimum sweep point requirements in all ranges, the global Sweep Points setting is increased. By default, each range is supplied with a minimum of one sweep point.

For details see "Sweep points" on page 103

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<range>:POINts:MIN[:VALue] on page 465

Insert before/after Range
Inserts a new range to the left (before) or to the right (after) of the range in which the cursor is currently displayed. The range numbers of the currently focused range and all higher ranges are increased accordingly. The maximum number of ranges is 30.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<range>:INSert on page 459

Delete Range
Deletes the currently focused range, if possible (The reference range cannot be deleted. A minimum of 3 ranges is required.) The range numbers are updated accordingly.

Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<range>:DELete` on page 456

Symmetric Setup
Any changes to the range settings in active "Symmetric Setup" mode lead to symmetrical changes in the other ranges (where possible). In particular, this means:

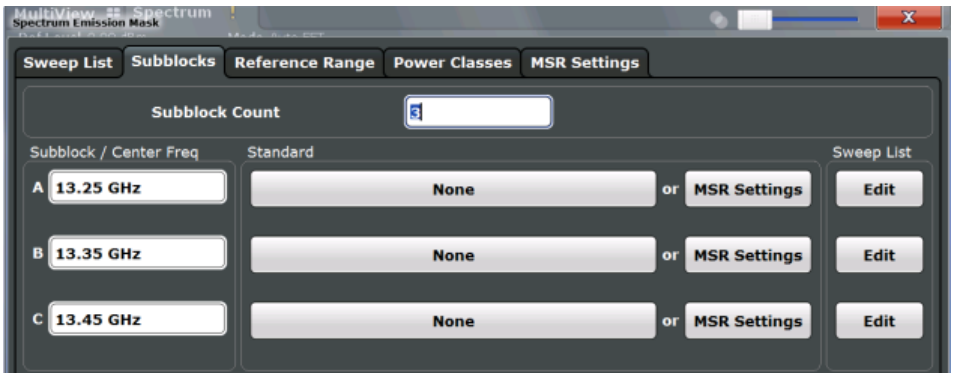
- Inserting ranges: a symmetrical range is inserted on the other side of the reference range
- Deleting ranges: the symmetrical range on the other side of the reference range is also deleted
- Editing range settings: the settings in the symmetrical range are adapted accordingly

Note: If "Fast SEM" mode is deactivated while "Symmetric Setup" mode is on, "Sym Setup" mode is automatically also deactivated.
If "Fast SEM" mode is activated while "Symmetric Setup" mode is on, not all range settings can be set automatically.

2.6.5.2 Multi-SEM (Sub Block) Settings

In the Spectrum application only, spectrum emissions can be measured for multiple sub blocks of channels (see chapter 2.6.4.5, "SEM with Multiple Sub Blocks ("Multi-SEM")", on page 108). Sub blocks are a set of multiple ranges around a defined center frequency (carrier). Global settings on the sub blocks are configured in the "Sub Blocks" tab of the "Spectrum Emission Mask" configuration dialog box.

By default, a single sub block is assumed. If more than 1 sub blocks are defined, additional tabs are inserted for each sub block in the individual tabs of the "Spectrum Emission Mask" configuration dialog box.



Sub Block Count 119
Sub Block Center Frequency 119
Standard / MSR Settings 119
Edit sweep list 119

Sub Block Count
Defines the number of sub blocks. By default, the familiar SEM measurement with just one single block of ranges is configured.

Remote command:
`[SENSe:]ESPectrum<sb>:SBCOUNT` on page 453

Sub Block Center Frequency
Defines the center frequency for an individual sub block. The center frequency determines the reference range used for each block.

For measurements with only 1 sub block, this setting corresponds to the global setting in the "Frequency" settings (see Center frequency).

Remote command:
`[SENSe:]ESPectrum<sb>:SBCENTER` on page 453

Standard / MSR Settings
Defines the use of a standard settings file or a multi-standard radio configuration for a particular sub block. For details see chapter 2.6.5.6, "Standard Files", on page 125 and chapter 2.6.5.5, "MSR Settings", on page 122.

Note that *either* a standard *or* an MSR setting can be selected; if one is selected, the other is disabled.

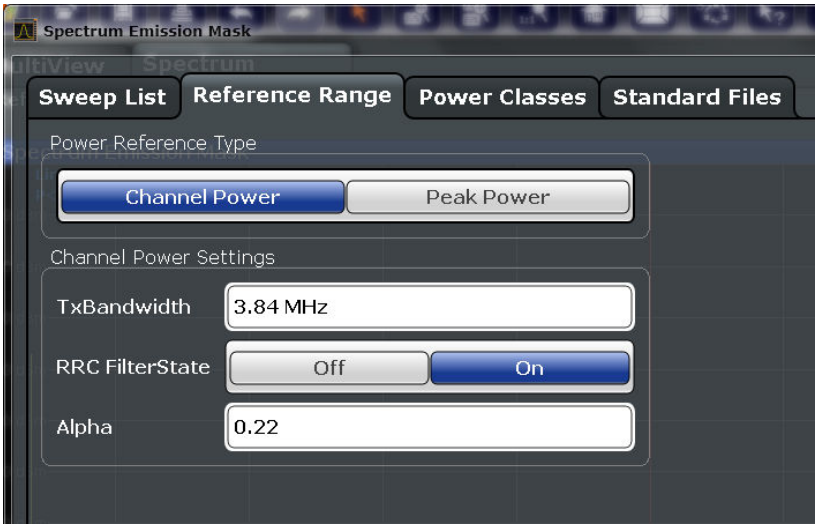
Remote command:
`[SENSe:]ESPectrum<sb>:PRESet[:STANdard]` on page 450
chapter 5.2.7.3, "Configuring Multi SEM Measurements", on page 452

Edit sweep list
Switches to the "Sweep List" tab of the "Spectrum Emission Mask" dialog box to configure the individual frequency ranges and mask limits for the corresponding sub block. See chapter 2.6.5.1, "Sweep List", on page 112.

2.6.5.3 Reference Range

The range centered around the center frequency is defined as the reference range for all other ranges in the sweep list.

In the "Reference Range" tab of the "Spectrum Emission Mask" dialog box you define the general settings for the reference range.



Power Reference Type 120
Channel Power Settings 120
└ Tx Bandwidth 120
└ RRC Filter State 120
└ Alpha 121

Power Reference Type
Defines how the reference power is calculated.

"Channel Power"
Measures the channel power within the reference range using the integration bandwidth method (see also "IBW method" on page 41). Additional settings can be configured for this method.

"Peak Power"
Determines the peak power within the reference range.

Remote command:
`[SENSe:]ESPectrum<sb>:RTYPe` on page 468

Channel Power Settings
If the Power Reference Type "Channel Power" was selected, additional parameters can be configured.

Tx Bandwidth ← Channel Power Settings
Defines the bandwidth used for measuring the channel power, with:

minimum span ≤ Tx Bandwidth ≤ span of reference range

Remote command:
`[SENSe:]ESPectrum<sb>:BWID` on page 467

RRC Filter State ← Channel Power Settings
Activates or deactivates the use of an RRC filter.

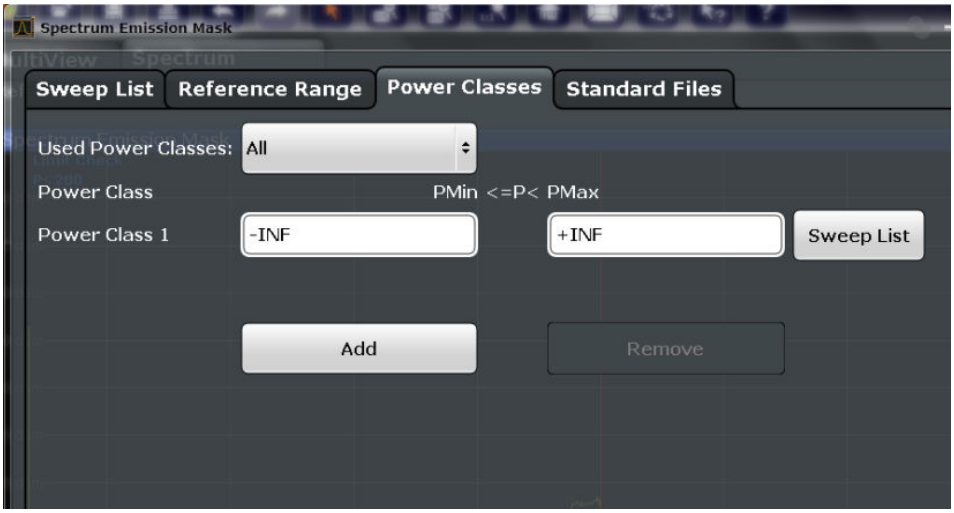
Remote command:
`[SENSe:]ESPectrum<sb>:FILTer[:RRC][:STATe]` on page 468

Alpha ← Channel Power Settings
Sets the alpha value of the RRC filter (if activated).

Remote command:
[SENSe:]ESPectrum<sb>:FILTer[:RRC]:ALPHa on page 468

2.6.5.4 Power Classes

In the "Power Classes" tab of the "Spectrum Emission Mask" dialog box you configure power classes for which you can then define sweep list ranges. For details see "Power classes" on page 103.



Used Power Classes....121
PMin/PMax....122
Sweep List....122
Adding or Removing a Power Class....122

Used Power Classes
Defines which power classes are considered for the SEM measurement. Limits can be defined only for used power classes. It is only possible to select either one specific power class or all of the defined power classes.

If "All" is selected, the power class that corresponds to the currently measured power in the reference range is used for monitoring. The limits assigned to that power class are applied (see "Abs Limit Start/Stop <n>" on page 116 and "Rel Limit Start/Stop <n>" on page 116).

Remote command:
CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>[:EXCLusive]
on page 473
To define all limits in one step:
CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:LIMit[:STATe]
on page 471

PMin/PMax
Defines the power limits for each power class. The first range always starts at -200 dBm (-INF) and the last range always stops at 200 dBm (+INF). These fields cannot be modified. If more than one power class is defined, the value of "PMin" must be equal to the value of "PMax" of the previous power class and vice versa.

Note that the power level may be equal to the lower limit(s), but must be lower than the upper limit(s):

$P_{min} \leqq P < P_{max}$

Otherwise the ranges are corrected automatically.

Remote command:
`CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:MINimum` on page 472
`CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:MAXimum` on page 471

Sweep List
Switches to the "Sweep List" tab of the "Spectrum Emission Mask" dialog box and focuses the "Limit Check" setting for the corresponding power class (1-4) in the reference range (see "Limit Check <n>" on page 116).

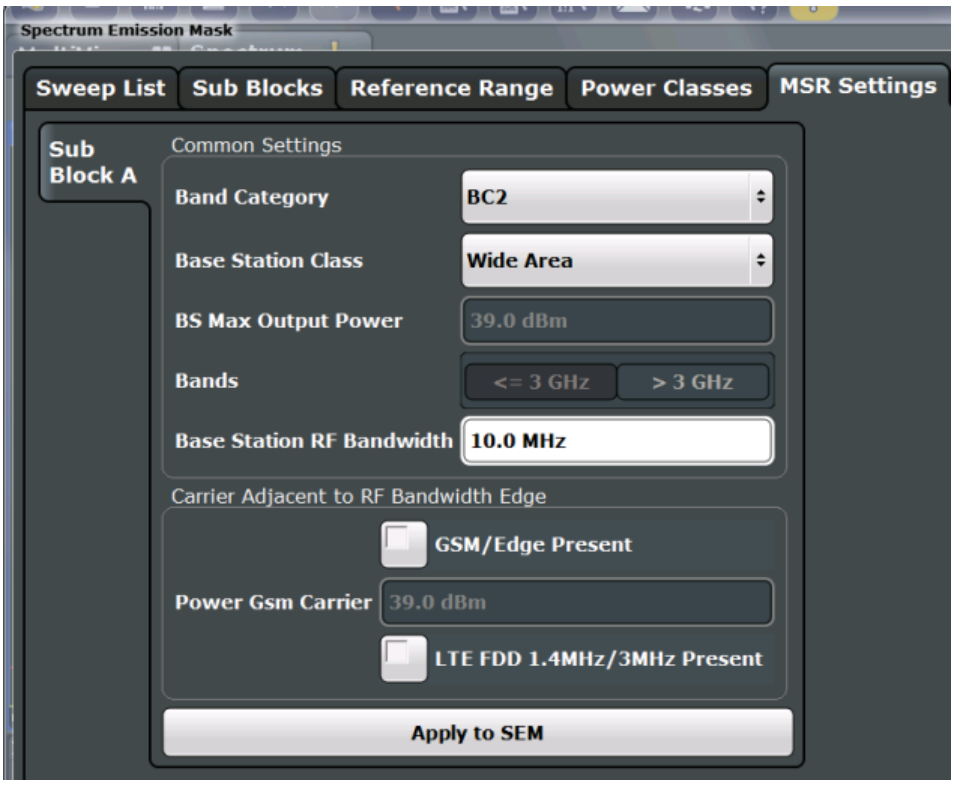
Adding or Removing a Power Class
Adds a new power class at the end of the list or removes the last power class. After adding or removing, the last power class is adapted to end at "+INF". Note that a maximum of 4 power classes are available.

Remote command:
`CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass:COUNt` on page 471

2.6.5.5 MSR Settings

In the "MSR Settings" tab of the "Spectrum Emission Mask" dialog box you configure multi-standard radio (MSR) measurements, which allow you to perform SEM tests on multiple carriers using different digital standards.

For details see chapter 2.6.4.4, "Multi-Standard Radio (MSR) SEM Measurements", on page 108.



Band Category 123
Base Station Class 123
Base Station Maximum Output Power 124
Bands 124
Base Station RF Bandwidth 124
Carrier Adjacent to RF Bandwidth Edge 124
Power GSM Carrier 124
Apply to SEM 125

Band Category
Defines the band category for MSR measurements, i.e. the combination of available carriers to measure.

"BC1" LTE FDD and W-CDMA

"BC2" LTE FDD, W-CDMA and GSM/EDGE

"BC3" LTE TDD and TD-SCDMA

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:BCATegory` on page 475

Base Station Class
Defines the class of the base station according to its sending range.

This setting is required to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0.

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:CLAS` on page 476

Base Station Maximum Output Power
Defines the maximum output power of the base station. Possible values are from 0 to 100 dBm in 1 dB steps.

This setting is only available for base stations with a medium range Base Station Class.

This value is required to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0.

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:MPOWer` on page 478

Bands
Defines the frequency range of the bands used by the base station.

This setting is only available for Band Category 1 or 3.

This setting is required to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0.

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:BAND` on page 474

Base Station RF Bandwidth
Defines the relevant RF bandwidth (span) required to measure all available carriers in MSR SEM measurements.

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:RFBWidth` on page 479

Carrier Adjacent to RF Bandwidth Edge
For particular measurement setups the specification demands specific limits for the SEM ranges.

These settings are only available for Band Category 2.

"GSM/EDGE present"
A GSM/EDGE carrier is located at the edge of the RF band.
In this case, the power of the GSM carrier must be specified (see "Power GSM Carrier" on page 124).

"LTE FDD 1.4 MHz / 3 MHz present"
An LTE FDD 1.4 MHz or 3 MHz carrier is located at the edge of the RF band.

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:GSM:CPResent` on page 477
`[SENSe:]ESPectrum<sb>:MSR:LTE:CPResent` on page 478

Power GSM Carrier
Defines the power of the GSM carrier (if available, see "Carrier Adjacent to RF Bandwidth Edge" on page 124). Possible values are from 0 to 100 dBm in 1 dB steps.

This setting is only available for Band Category2.

This setting is required to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0.

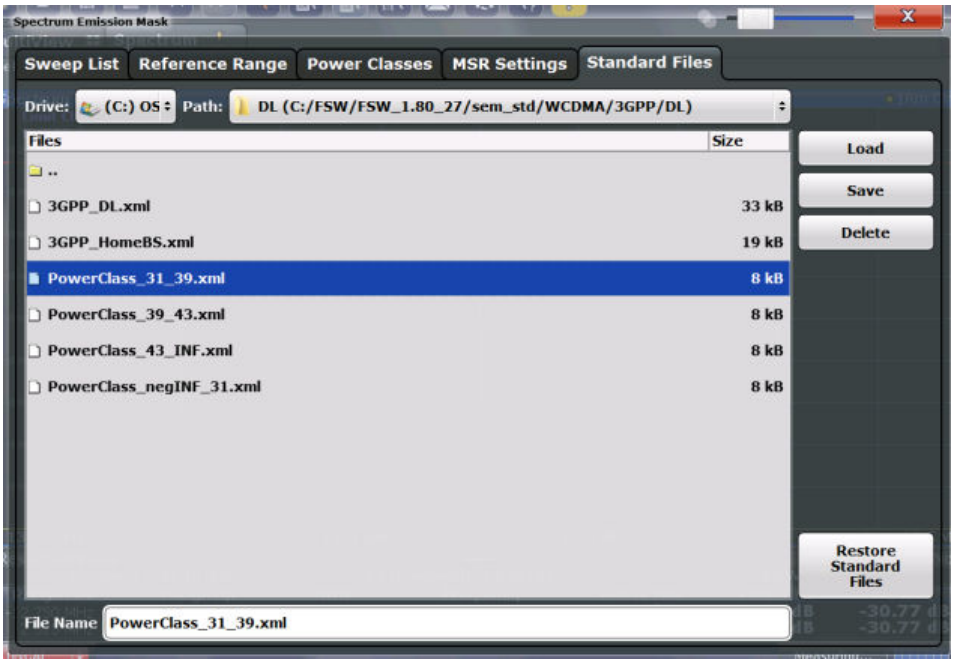
Remote command:
[SENSe:]ESPectrum<sb>:MSR:GSM:CARR on page 476

Apply to SEM
Configures the SEM sweep list according to the specified MSR settings.

Remote command:
[SENSe:]ESPectrum<sb>:MSR:APPLy on page 474

2.6.5.6 Standard Files

In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box you can save the current measurement settings as a user-defined standard (xml file), or load stored measurement settings. Furthermore, you can delete an existing settings file.



For details see chapter 2.6.6.1, "How to Manage SEM Settings Files", on page 131.

Standard files for sub blocks (Multi-SEM measurements)
If more than 1 sub blocks are defined, the "Standard Files" tab and softkey are not available. To load a standard file for an individual sub block, use the Standard / MSR Settings setting in the "Sub Blocks" tab.

Selecting the Storage Location - Drive/ Path/ Files....126
File Name....126
Load Standard....126

Save Standard 127
Delete Standard 127
Restore Standard Files 127

Selecting the Storage Location - Drive/ Path/ Files
Select the storage location of the settings file on the instrument or an external drive.

The "Drive" indicates the internal (C:) or any connected external drives (e.g. a USB storage device).

The "Path" contains the drive and the complete file path to the currently selected folder.

The "Files" list contains all subfolders and files of the currently selected path.

The default storage location for the SEM settings files is: `C:\R_S\instr\sem_std`.

Note: Saving instrument settings in secure user mode.
In secure user mode, settings that are to be stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error may occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSWP User Manual..

Remote command:
`MMEMory:CATalog?`

File Name
Contains the name of the data file without the path or extension.

By default, the name of a settings file consists of a base name followed by an underscore. Multiple files with the same base name are extended by three numbers, e.g. `limit_lines_005`.

For details on the file name and location see the R&S FSWP User Manual.

Note: Saving instrument settings in secure user mode.
In secure user mode, settings that are to be stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error may occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSWP User Manual..

Load Standard
Loads the selected measurement settings file.

Remote command:
`[SENSe:]ESPectrum<sb>:PRESet[:STANdard]` on page 450

Save Standard
Saves the current measurement settings for a specific standard as a file with the defined name.

Remote command:
`[SENSe:]ESPectrum<sb>:PRESet:STORe` on page 451

Delete Standard
Deletes the selected standard. Standards predefined by Rohde & Schwarz can also be deleted. A confirmation query is displayed to avoid unintentional deletion of the standard.

Note: Restoring predefined standard files. The standards predefined by Rohde & Schwarz available at the time of delivery can be restored using the "Restore Standards" function (see "Restore Standard Files" on page 127).

Restore Standard Files
Restores the standards predefined by Rohde & Schwarz available at the time of delivery.

The XML files from the `C:\R_S\instr\sem_backup` folder are copied to the `C:\R_S\instr\sem_std` folder.

Note that this function will overwrite customized standards that have the same name as predefined standards.

Remote command:
`[SENSe:]ESPectrum<sb>:PRESet:RESTore` on page 451

2.6.5.7 List Evaluation (Results Configuration)

In the "List Evaluation" dialog box, which is displayed when you select the "Analysis" button in the "Overview" dialog box, or the "List Evaluation" softkey in the "SEMAsk" menu, you configure the contents and display of the SEM results.

List Evaluation (Result Summary) State 128
Show Peaks 128
Margin 128
Saving the Result Summary (Evaluation List) to a File 128

List Evaluation (Result Summary) State
Activates or deactivates the Result Summary.

Remote command:
`CALCulate<n>:ESPectrum:PEAKsearch:AUTO` on page 480
`TRACe<n>[:DATA]` on page 606

Show Peaks
If activated, all peaks that have been detected during an active SEM measurement are marked with blue squares in the Spectrum diagram.

Remote command:
`CALCulate<n>:ESPectrum:PEAKsearch:PSHow` on page 480

Margin
Although a margin functionality is not available for the limit check, a margin (threshold) for the peak values to be displayed in the result summary (and diagram, if activated) can be defined. Only peaks that exceed the margin value are displayed.

Remote command:
`CALCulate<n>:ESPectrum:PEAKsearch:MARGin` on page 480

Saving the Result Summary (Evaluation List) to a File
Exports the Result Summary of the SEM measurement to an ASCII file for evaluation in an external application. If necessary, change the decimal separator for evaluation in other languages.

Define the file name and storage location in the file selection dialog box that is displayed when you select the "Save" function.

For details see chapter 2.6.8.2, "ASCII File Export Format (Spectrum Emission Mask)", on page 140.

Remote command:
`MMEMory:STORe<n>:LIST` on page 481
`FORMat:DEXPort:DSEParator` on page 615

2.6.6 How to Perform a Spectrum Emission Mask Measurement

SEM measurements can be performed according to a specific standard or freely configured. Configuration for signals with a very regular channel definition can be configured very quickly and easily. Selecting the SEM measurement is a prerequisite for all other tasks. For multi-standard radio SEM measurements, configuration for specified scenarios can be done automatically.

For signals with multiple carriers, also in non-contiguous ranges, an SEM measurement with multiple sub blocks can be configured.

The following tasks are described:

- "To select an SEM measurement" on page 129
- "To perform an SEM measurement according to a standard" on page 129
- "To configure a user-defined SEM measurement" on page 129
- "To perform an MSR SEM measurement" on page 130
- "To perform a Multi-SEM measurement" on page 131

To select an SEM measurement

► Press the MEAS key, then select the "Spectrum Emission Mask" measurement.

To perform an SEM measurement according to a standard

► Load the settings file as described in "How to load an SEM settings file" on page 132 and start a measurement.

To configure a user-defined SEM measurement

1. Define the span of the signal to be monitored in the general span settings.
2. Split the frequency span of the measurement into ranges for signal parts with similar characteristics.
   Starting from the center frequency, determine which sections of the signal to the left and right can be swept and monitored using the same parameters. Criteria for such a range definition may be, for example:
   - The signal power level
   - The required resolution bandwidth or sweep time
   - Transducer factors
   - Permitted deviation from the defined signal level, i.e. the required limit values for monitoring

   If the signal consists of a transmission channel and adjacent channels, the channel ranges can usually be used for the range definition.
3. If the signal power level to be monitored may vary and the limits will vary accordingly, define power classes. For each range of levels that can be monitored in the same way, define a power class.
   a) Select the "Overview" softkey, then select the "SEM Setup" button and switch to the "Power Classes" tab.
   b) Add a power class by selecting the "Add" button.
   c) Enter the start and stop power levels to define the class.
   d) Select the power classes to be used for the current measurement: either a specific class, or all classes, to have the required class selected automatically according to the input level measured in the reference range.
4. Select the "Sweep List" tab of the "Spectrum Emission Mask" dialog box.
5. Insert the required ranges using the "Insert before Range" and "Insert after Range" buttons, which refer to the currently selected range (the reference range by default).

If the signal trace is symmetric to the center frequency, activate the "Sym Setup" option to make setup easier and quicker.

6. Define the measurement parameters for each range as required. If symmetrical setup is activated, you only have to configure the ranges to one side of the center range.
   In particular, define the limits for each range of the signal, i.e. the area in which the signal level may deviate without failing the limit check. If several power classes were defined (see step 3), define limits for each power class.
   a) Define the type of limit check, i.e. whether absolute values or relative values are to be checked, or both. The type of limit check is identical for all power classes.
   b) Define the limit start and stop values.
7. If the sweep list settings - other than the limit and transducer values - are identical for several adjacent ranges, activate "Fast SEM" mode to speed up the measurement. You only have to activate the mode for one range, the others are adapted automatically.
8. If necessary, change the settings for the reference power to which all SEM results refer in the "Reference Range" tab.
9. To indicate the determined peaks in the display during an SEM measurement, select the "Analysis" button in the "Overview" and activate the "Show Peaks" option.
10. To save the current SEM measurement settings to a file to re-use them later, save a settings file as described in "How to save a user-defined SEM settings file" on page 132.
11. Start a sweep.

    The determined powers and limit deviations for each range are indicated in the Result Summary. If activated, the peak power levels for each range are also indicated in the Spectrum diagram.
12. To save the Result Summary, export the results to a file as described in chapter 2.6.6.2, "How to Save SEM Result Files", on page 132.

To perform an MSR SEM measurement

1. Select the "MSR Config" softkey.
2. Select the band category that determines the digital standards used in the measurement setup (see "Band Category" on page 123).
3. Define the bandwidth that contains all relevant carrier signals to be measured.
4. For measurements with GSM/EDGE, LTE FDD and W-CDMA carriers (BC2), define whether a GSM/EDGE or an LTE FDD carrier, or both, are located at the edge of the bandwidth.
5. Select the "Apply to SEM" button.

The sweep list is configured according to the MSR specification, with the required number of ranges and defined limits.

6. Start a sweep.

   The determined powers and limit deviations for each range are indicated in the Result Summary. If activated, the peak power levels for each range are also indicated in the Spectrum diagram.

7. To save the Result Summary, export the results to a file as described in chapter 2.6.6.2, "How to Save SEM Result Files", on page 132.

To perform a Multi-SEM measurement

1. Define the span of the signal to be monitored in the general span settings.
2. Select the "Multi-SEM Config" softkey.
3. Define the number of sub blocks (up to 3) that contain the relevant carriers.
4. For each sub block, define the center frequency, that is, the frequency of the TX carrier or a frequency in the dedicated reference range.
5. For each sub block, do one of the following:
   a) Select a standard settings file to be used.
   b) Select the "MSR Settings" button and define the MSR configuration as described in "To perform an MSR SEM measurement" on page 130.
   c) Select the "Edit" button and configure the sweep list manually as defined in "To configure a user-defined SEM measurement" on page 129. Be sure to select the correct vertical tab for the corresponding sub block within each subtab of the "Spectrum Emission Mask" configuration dialog.
   Define a function to be used for overlapping ranges in the "Multi-Limit Calc" field of the sweep list.
6. Start a sweep.

   The determined powers and limit deviations for each sub block, each gap, and each range are indicated in the Result Summary. If activated, the peak power levels for each range are also indicated in the Spectrum diagram.

7. To save the Result Summary, export the results to a file as described in chapter 2.6.6.2, "How to Save SEM Result Files", on page 132.

2.6.6.1 How to Manage SEM Settings Files

SEM measurement settings can be saved to an xml file which can then be exported to another application or loaded on the R&S FSWP again at a later time. Some predefined XML files are provided that contain ranges and parameters according to the selected standard. All XML files are stored under `C:\r_s\instr\sem_std`.

For details on the file format of the SEM settings file, see chapter 2.6.8.1, "Format Description of SEM XML Files", on page 134.

SEM settings or standard files are managed in the "Standards" tab of the "Spectrum Emission Mask" dialog box. To display this dialog box, select the "Overview" softkey and then the "SEM Setup" button.

How to load an SEM settings file

1. From the file selection dialog box, select the settings file (with an ".xml" extension).
2. Select the "Load" button.

   The settings from the selected file are restored to the R&S FSWP and you can repeat the SEM measurement with the stored settings.

How to save a user-defined SEM settings file

1. Configure the SEM measurement as required (see chapter 2.6.6, "How to Perform a Spectrum Emission Mask Measurement", on page 128).
2. In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, define a file name and storage location for the settings file.
3. Select the "Save" button.

   The settings are stored to a file with the extension ".xml" as specified.

How to delete an SEM settings file

1. In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, select the file you want to delete.
2. Select the "Delete" button.
3. Confirm the message.

   The settings file is removed from the R&S FSWP.

How to restore default SEM settings files

The R&S FSWP is delivered with predefined settings files which can be edited and overwritten. However, you can restore the original files.

► In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, select the "Restore Standard Files" button.

The original predefined settings files are available for selection on the R&S FSWP.

2.6.6.2 How to Save SEM Result Files

The Result Summary from an SEM measurement can be saved to a file, which can be exported to another application for further analysis, for example.

For details on the file format of the SEM export file, see chapter 2.6.8.2, "ASCII File Export Format (Spectrum Emission Mask)", on page 140.

1. Configure and perform an SEM measurement as described in chapter 2.6.6, "How to Perform a Spectrum Emission Mask Measurement", on page 128.

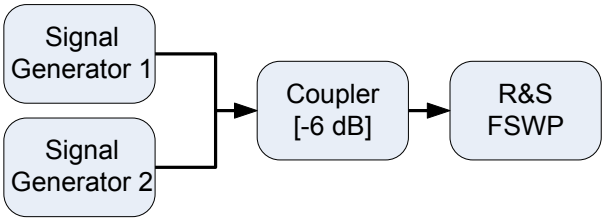
2. In the "Overview", select the "Analysis" button.
3. If necessary, change the "Decimal Separator" to "COMMA" for evaluation in other languages.
4. Select the "Save" button.
5. In the file selection dialog box, select a storage location and file name for the result file.
6. Select the "Save" button.

   The file with the specified name and the extension `.dat` is stored in the defined storage location.

2.6.7 Measurement Example: Multi-SEM Measurement

The following measurement example demonstrates an SEM measurement for a signal with multiple sub blocks.

Test setup:



Signal generator settings (e.g. R&S FSWP SMW):

Device	Standard	Center Frequency	Level	Test Model
SigGen 1	3GPP/FDD	900 MHz	0 dBm	1-16
SigGen 2	EUTRA/LTE	906.5 MHz	0 dBm	1_1_5MHz

Setting up the measurement

1. Preset the R&S FSWP.
2. Set the center frequency to *903.25 MHz*.
3. Set the reference level to *10 dBm* with an offset of to *30 dB*.
4. Press the MEAS key and select the "SEM" measurement function from the "Select Measurement" dialog box.
5. Select the "Sub Blocks" softkey and define a subblock count of 2.
6. For sub block A, define the settings for the 3GPP/FDD signal:
   a) Set the center frequency to *900 MHz*
   b) Select "MSR Settings".

c) Set the "Base Station RF Bandwidth" to *5 MHz*.
d) Select "Apply to SEM".

7. For sub block B, define the settings for the EUTRA/LTE signal:

a) Set the center frequency to *906.5 MHz*
b) Select "MSR Settings".
c) Set the "Base Station RF Bandwidth" to *5 MHz*.
d) Select "Apply to SEM".

8. Select RUN SINGLE to perform a measurement with the new settings.

The results of the measurement for each sub block are displayed in the Result Summary. The summarized limit line is indicated in the Spectrum graph.

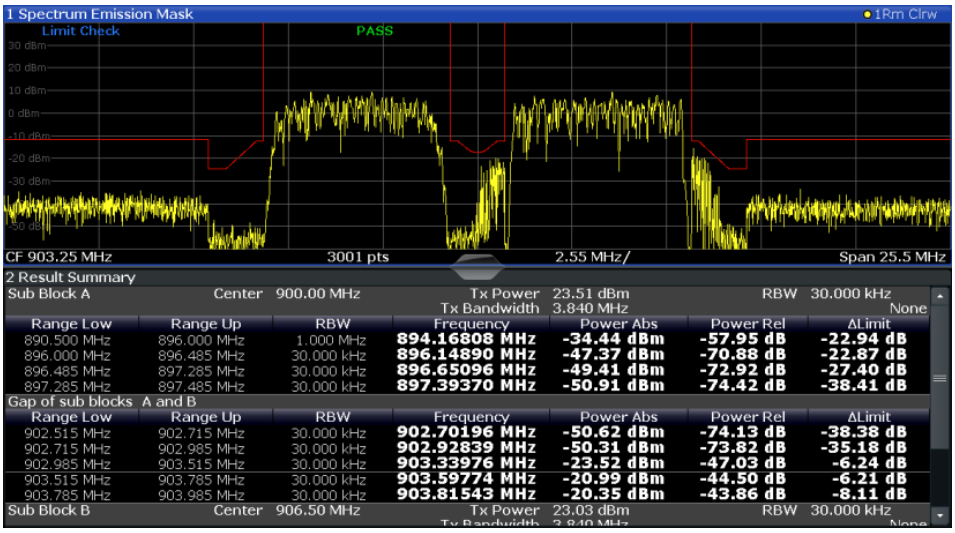

1 Spectrum Emission Mask
Limit Check
PASS
CF 903.25 MHz
3001 pts
2.55 MHz/
Span 25.5 MHz
2 Result Summary
Sub Block A
Center 900.00 MHz
Tx Power 23.51 dBm
Tx Bandwidth 3.840 MHz
RBW 30.000 kHz
Range Low | Range Up | RBW | Frequency | Power Abs | Power Rel | ΔLimit
890.500 MHz | 896.000 MHz | 1.000 MHz | 894.16808 MHz | -34.44 dBm | -57.95 dB | -22.94 dB
896.000 MHz | 896.485 MHz | 30.000 kHz | 896.14890 MHz | -47.37 dBm | -70.88 dB | -22.87 dB
896.485 MHz | 897.285 MHz | 30.000 kHz | 896.65096 MHz | -49.41 dBm | -72.92 dB | -27.40 dB
897.285 MHz | 897.485 MHz | 30.000 kHz | 897.39370 MHz | -50.91 dBm | -74.42 dB | -38.41 dB
Gap of sub blocks A and B
902.515 MHz | 902.715 MHz | 30.000 kHz | 902.70196 MHz | -50.62 dBm | -74.13 dB | -38.38 dB
902.715 MHz | 902.985 MHz | 30.000 kHz | 902.92839 MHz | -50.31 dBm | -73.82 dB | -35.18 dB
902.985 MHz | 903.515 MHz | 30.000 kHz | 903.33976 MHz | -23.52 dBm | -47.03 dB | -6.24 dB
903.515 MHz | 903.785 MHz | 30.000 kHz | 903.59774 MHz | -20.99 dBm | -44.50 dB | -6.21 dB
903.785 MHz | 903.985 MHz | 30.000 kHz | 903.81543 MHz | -20.35 dBm | -43.86 dB | -8.11 dB
Sub Block B
Center 906.50 MHz
Tx Power 23.03 dBm
RBW 30.000 kHz

Fig. 2-38: Multi-SEM measurement: results of the measurement for each sub block

2.6.8 Reference: SEM File Descriptions

This reference provides details on the format of the SEM settings and result files.

- Format Description of SEM XML Files 134
- ASCII File Export Format (Spectrum Emission Mask) 140

2.6.8.1 Format Description of SEM XML Files

The SEM XML files offer a quick way to change the measurement settings. A set of ready-made XML files for different standards is already provided. You can also create and use your own XML files. Alternatively, edit the settings directly in the "Spectrum Emission Mask" dialog box and save the XML file afterwards. This way, no modifications have to be done in the XML file itself.

In addition to saving the current settings to a file, settings files can also be created independently of the R&S FSWP, in an external application. When creating your own XML files, be sure to comply with the following conventions because the R&S FSWP

can only interpret XML files of a known structure. For sample files look in the `C:\r_s\instr\sem_std` directory of the R&S FSWP.

To load a settings file, use the "Load" function in the "Standard Files" tab of the "Spectrum Emission Mask" dialog box (see "How to load an SEM settings file" on page 132). All XML files are stored under `C:\r_s\instr\sem_std`.

The files for importing range settings obey the rules of the XML standard. The child nodes, attributes, and structure defined for the data import are described here.

Be sure to follow the structure exactly as shown below or else the R&S FSWP is not able to interpret the XML file and error messages are shown on the screen. It is recommended that you make a copy of an existing file and edit the copy of the file.

Basically, the file consists of three elements that can be defined:

- The "BaseFormat" element
- The "PowerClass" element
- The "Range" element

The "BaseFormat" element

It carries information about basic settings. In this element only the "ReferencePower" child node has any effects on the measurement itself. The other attributes and child nodes are used to display information about the Spectrum Emission Mask Standard on the measurement screen. The child nodes and attributes of this element are shown in table 2-13.

Example:

In the sample file `PowerClass_39_43.xml` under `C:\r_s\instr\sem_std\WCDMA\3GPP`, these attributes are defined as follows:

- Standard="W-CDMA 3GPP"
- LinkDirection="DL"
- PowerClass="(39,43)dBm"

The "PowerClass" element

It is embedded in the "BaseFormat" element and contains settings information about the power classes. Up to four different power classes can be defined. For details refer to chapter 2.6.5.4, "Power Classes", on page 121. The child nodes and attributes of this element are shown in table 2-14.

The "Range" element

This element is embedded in the "PowerClass" element. It contains the settings information of the range. There have to be at least three defined ranges: one reference range and at least one range to either side of the reference range. The maximum number of ranges is 30. Note that the R&S FSWP uses the same ranges in each power class. Therefore, the contents of the ranges of each defined power class have to be identical to the first power class. An exception are the Start and Stop values of the two

Limit nodes that are used to determine the power class. Note also, that there are two Limit nodes to be defined: one that gives the limit in absolute values and one in relative values. Make sure units for the Start and Stop nodes are identical for each Limit node.

For details refer to chapter 2.6.5.1, "Sweep List", on page 112. The child nodes and attributes of this element are shown in table 2-15.

The following tables show the child nodes and attributes of each element and show if a child node or attribute is mandatory for the R&S FSWP to interpret the file or not. Since the hierarchy of the XML can not be seen in the tables, either view one of the default files already stored on the R&S FSWP in the "`C:\r_s\instr\sem_std`" directory or check the structure as shown below.

Below, a basic example of the structure of the file is shown, containing all mandatory attributes and child nodes. Note that the "PowerClass" element and the range element are themselves elements of the "BaseFormat" element and are to be inserted where noted. The separation is done here simply for reasons of a better overview. Also, no example values are given here to allow a quick reference to the tables above. Italic font shows the placeholders for the values.

- The "BaseFormat" element is structured as follows:
  – <RS_SEM_ACP_FileFormat Version="1.0.0.0">
  <Name>"Standard"</Name>
  <Instrument>
  <Type>"Instrument Type"</Type>
  <Application>"Application"</Application>
  </Instrument>
  <LinkDirection Name="Name">
  <ReferencePower>
  <Method>"Method"</Method>
  </ReferencePower>
  <PowerClass Index="n">
  <!-- For contents of the PowerClass node see table 2-14 -->
  <!-- Define up to four PowerClass nodes -->
  </PowerClass>
  </LinkDirection>
  </RS_SEM_ACP_File>
- The "PowerClass" element is structured as follows:
  – <PowerClass Index="n">
  <StartPower Unit="dBm" InclusiveFlag="true" Value="StartPowerValue"/>
  <StopPower Unit="dBm" InclusiveFlag="false" Value="StopPowerValue"/>
  <DefaultLimitFailMode>"Limit Fail Mode"</DefaultLimitFailMode>
  <Range Index="n">
  <!-- For contents of the Range node see table 2-15 -->
  <!-- Define up to twenty Range nodes -->
  </Range>
  …
  </PowerClass>
- The "Range" element is structured as follows:
  – <Range Index="n">
  <Name="Name">

```
<ChannelType>"Channel Type"</Channel Type>
<WeightingFilter>
<Type>"FilterType"</Type>
<RollOffFactor>"Factor"</RollOffFactor>
<Bandwith>"Bandwidth"</Bandwidth>
</WeightingFilter>
<FrequencyRange>
<Start>"RangeStart"</Start>
<Stop>"RangeStop"</Stop>
</FrequencyRange>
<Limit>
<Start Unit="Unit" Value="Value"/>
<Stop Unit="Unit" Value="Value"/>
</Limit>
<Limit>
<Start Unit="Unit" Value="Value"/>
<Stop Unit="Unit" Value="Value"/>
</Limit>
<RBW Bandwidth="Bandwidth" Type="FilterType"/>
<VBW Bandwidth="Bandwidth"/>
<Detector>"Detector"</Detector>
<Sweep Mode="SweepMode" Time="SweepTime"/>
<Amplitude>
<ReferenceLevel Unit="dBm" Value="Value"/>
<RFAttenuation Mode="Auto" Unit="dB" Value="Value"/>
<Preamplifier State="State"/>
</Amplitude>
<MeasPointsMin>1</MeasPointsMin>
<CalcRuleMulti>Sum</CalcRuleMulti>
</Range>
```

Table 2-13: Attributes and child nodes of the BaseFormat element

Child Node	Attribute	Value	Parameter Description	Mand.
	FileFormatVersion	1.0.0.0		Yes
	Date	YYYY-MM-DD HH:MM:SS	Date in ISO 8601 format	No
Name		<string>	Name of the standard	Yes
Instrument	Type	FSL	Name of the instrument	No
	Application	SA | K72 | K82	Name of the application	No
LinkDirection	Name	Downlink | Uplink | None		Yes
	ShortName	DL | UL		No
Reference-Power				Yes

Child Node	Attribute	Value	Parameter Description	Mand.
Method	TX Channel Power | TX Channel Peak Power			Yes
Reference-Channel	<string>			No

Table 2-14: Attributes and child nodes of the PowerClass element

Child Node	Attribute	Value	Parameter Description	Mand.
StartPower	Value	<power in dBm>	The start power must be equal to the stop power of the previous power class. The StartPower value of the first range is -200	Yes
	Unit	dBm		Yes
	InclusiveFlag	true		Yes
StopPower	Value	<power in dBm>	The stop power must be equal to the start power of the next power class. The StopPower value of the last range is 200	Yes
	Unit	dBm		
	InclusiveFlag	false		Yes
DefaultLimitFailMode		Absolute | Relative | Absolute and Relative | Absolute or Relative		Yes

Table 2-15: Attributes and child nodes of the Range element (normal ranges)

Child Node	Attribute	Value	Parameter Description	Mand.
	Index	0…19	Indices are continuous and have to start with 0	Yes
	Name	<string>	Name of the range	Only if ReferenceChannel contains a name and the range is the reference range
	Short-Name	<string>	Short name of the range	No
ChannelType		TX | Adjacent		Yes
WeightingFilter				Only if ReferencePower method is TX Channel Power and the range is the reference range
Type		RRC | CFilter	Type of the weighting filter	Yes

Child Node	Attribute	Value	Parameter Description	Mand.
Roll Off Factor		0…1	Excess bandwidth of the filter	Only if the filter type is RRC
Bandwidth		<bandwidth in Hz>	Filter bandwidth	Only if the filter type is RRC
FrequencyRange				Yes
Start		<frequency in Hz>	Start value of the range	Yes
Stop		<frequency in Hz>	Stop value of the range	Yes
Limit		dBm/Hz | dBm | dBc | dBr | dB	A Range must contain exactly two limit nodes; one of the limit nodes has to have a relative unit (e.g. dBc), the other one must have an absolute unit (e.g. dBm)	Yes
Start	Value	<numeric_value>	Power limit at start frequency	Yes
	Unit	dBm/Hz | dBm | dBc | dBr | dB	Sets the unit of the start value	
Stop	Value	<numeric_value>	Power limit at stop frequency	
	Unit	dBm/Hz | dBm | dBc | dBr | dB	Sets the unit of the stop value	
LimitFailMode		Absolute | Relative | Absolute and Relative | Absolute or Relative	If used, it has to be identical to DefaultLimitFailMode	No
RBW	Bandwidth	<bandwidth in Hz>	"RBW" on page 114	Yes
	Type	NORM | PULS | CFIL | RRC		No
VBW	Bandwidth	<bandwidth in Hz>	"VBW" on page 114	Yes
Detector		NEG | POS | SAMP | RMS | AVER | QUAS	If used, it has to be identical in all ranges.	No
Sweep	Mode	Manual | Auto	"Sweep Time Mode" on page 114	Yes
	Time	<time in sec>	"Sweep Time" on page 115	No
Amplitude				No
ReferenceLevel	Value	<power in dBm>	"Ref. Level" on page 115	Yes, if the ReferenceLevel child node is used
	Unit	dBm	Defines dBm as unit	Yes, if the ReferenceLevel node is used

Child Node	Attribute	Value	Parameter Description	Mand.
RFAttenuation	Mode	Manual | Auto	"RF Att. Mode" on page 115	Yes, if the ReferenceLevel child node is used
Preamplifier		ON | OFF	"Preamp" on page 115	Yes

2.6.8.2 ASCII File Export Format (Spectrum Emission Mask)

When trace data from an SEM measurement is exported, the data is stored in ASCII format as described below. The first part of the file lists information about the signal analyzer and the general setup.

File contents	Explanation
File header	
Type;FSWP-26	Model
Version;1.00;	Firmware version
Date;31.Mar 11;	Storage date of data set
Mode;ANALYZER;SEM;	Operating mode and measurement function
Center Freq;13250000000.000000;Hz	X-axis settings
Freq Offset;0.000000;Hz	
Span;25500000.000000;Hz	
x-Axis;LIN;	
Start;13237250000.000000;Hz	
Stop;13262750000.000000;Hz	
Level Offset;0.000000;dB	Y-axis settings
Ref Position;100.000000;%	
y-Axis;LOG;	
Level Range;100.000000;dB	
Trace settings	
Trace Mode;CLR/WRITE;	
Detector;RMS;	
Sweep Count;0;	
Trace 1:;	
x-Unit;Hz;	
y-Unit;dBm;	
List evaluation settings	
Margin;200;	Peak List margin

File contents	Explanation
Reference range settings	
RefType; CPOWER;	Reference power type
TxBandwidth;3840000;;Hz	Channel power settings
Filter State; ON;	
Alpha;0.22;	
PeaksPerRange;1;	Max. number of peaks per range to be detected
Values;2;	Number of detected peaks
File data section	
0;-12750000;-2515000;30000;13242367500;-43.844722747802734;-0.33028793334960938;49.669712066650391;FAIL;	Measured peak values: <range number>; <start frequency>; <stop frequency>; <resolution bandwidth of range>; <frequency of peak>; <absolute power in dBm of peak>; <relative power in dBc of peak>; (related to the channel power) <distance to the limit line in dB>; (positive value means above the limit) <limit fail (pass = 0, fail =1)>;
2;2515000;12750000;30000;13257632500;-43.844722747802734;-0.33028793334960938;49.669712066650391;FAIL;	

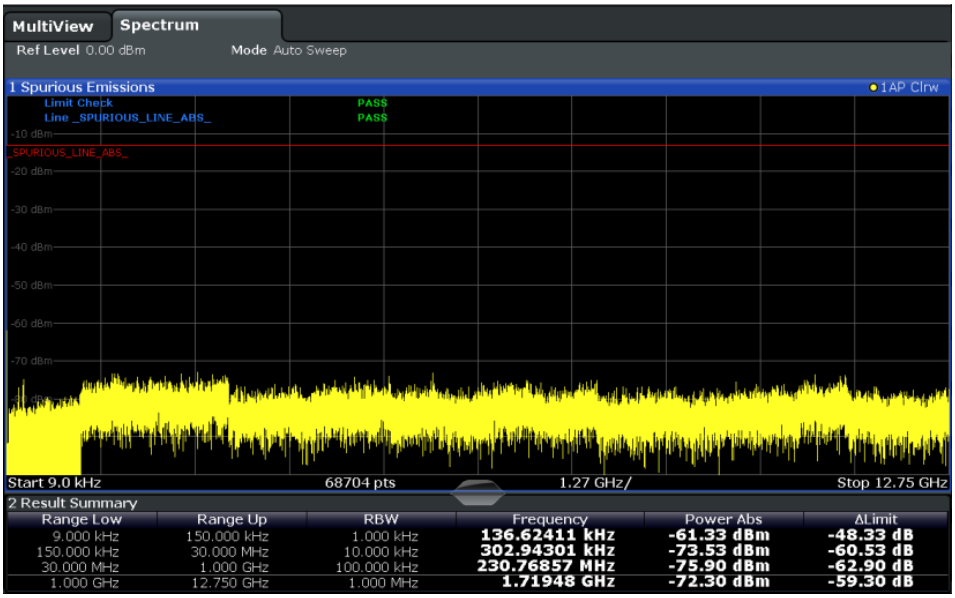
2.7 Spurious Emissions Measurement

The R&S FSWP supports Spurious Emissions measurements.

- About the Measurement....141
- Spurious Emissions Measurement Results....142
- Spurious Emissions Basics....143
- Spurious Emissions Measurement Configuration....145
- How to Perform a Spurious Emissions Measurement....151
- Reference: ASCII Export File Format (Spurious)....152

2.7.1 About the Measurement

The Spurious Emissions measurement monitors unwanted RF products outside the assigned frequency band generated by an amplifier. The spurious emissions are usually measured across a wide frequency range. The Spurious Emissions measurement allows a flexible definition of all parameters. A result table indicates the largest deviations of the absolute power from the limit line for each range, and the results can be checked against defined limits automatically.


MultiView
Spectrum
Ref Level 0.00 dBm
Mode Auto Sweep
1 Spurious Emissions
1AP Clrw
Limit Check PASS
Line _SPURIOUS_LINE_ABS_ PASS
-10 dBm
SPURIOUS_LINE_ABS_
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
Start 9.0 kHz
68704 pts
1.27 GHz/
Stop 12.75 GHz
2 Result Summary
Range Low | Range Up | RBW | Frequency | Power Abs | ΔLimit
9.000 kHz | 150.000 kHz | 1.000 kHz | 136.62411 kHz | -61.33 dBm | -48.33 dB
150.000 kHz | 30.000 MHz | 10.000 kHz | 302.94301 kHz | -73.53 dBm | -60.53 dB
30.000 MHz | 1.000 GHz | 100.000 kHz | 230.76857 MHz | -75.90 dBm | -62.90 dB
1.000 GHz | 12.750 GHz | 1.000 MHz | 1.71948 GHz | -72.30 dBm | -59.30 dB

2.7.2 Spurious Emissions Measurement Results

The measured signal, including any spurious emissions, and optionally the detected peaks are displayed in the Spurious Emissions measurement diagram. If defined, the limit lines and the limit check results are also indicated. In addition to the graphical results, a result table can be displayed to evaluate the measured powers and limit check results (see also chapter 2.7.3.2, "Limit Lines in Spurious Measurements", on page 144). The details of the evaluation list can be configured.

2 Result Summary
Range Low | Range Up | RBW | Frequency | Power Abs | ΔLimit
9.000 kHz | 150.000 kHz | 1.000 kHz | 136.62411 kHz | -61.33 dBm | -48.33 dB
150.000 kHz | 30.000 MHz | 10.000 kHz | 302.94301 kHz | -73.53 dBm | -60.53 dB
30.000 MHz | 1.000 GHz | 100.000 kHz | 230.76857 MHz | -75.90 dBm | -62.90 dB
1.000 GHz | 12.750 GHz | 1.000 MHz | 1.71948 GHz | -72.30 dBm | -59.30 dB

The following information is provided in the evaluation list for each range:

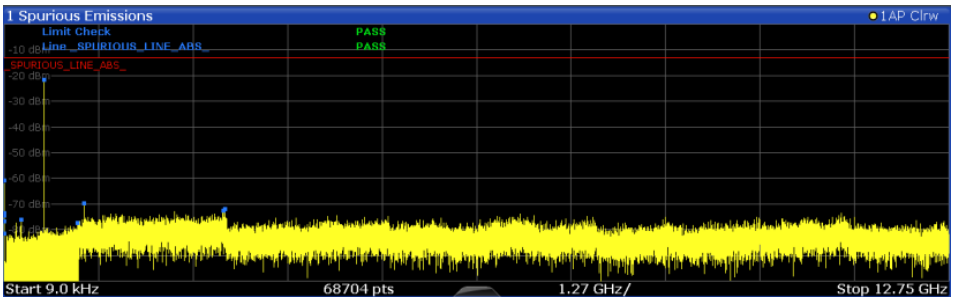
Column	Description
Range Low	Frequency range start for the range the peak value belongs to
Range Up	Frequency range end for the range the peak value belongs to
RBW	RBW of the range
Frequency	Frequency at the peak value
Power Abs	Absolute power level at the peak value
ΔLimit	Deviation of the absolute power level from the defined limit for the peak value

By default, one peak per range is displayed. However, you can change the settings to:

- Display all peaks
- Display a certain number of peaks per range

- Display only peaks that exceed a threshold ("Margin")

In addition to listing the peaks in the list evaluation, detected peaks can be indicated by blue squares in the diagram.



Furthermore, you can save the evaluation list to a file.

Retrieving Results via Remote Control

The measured spurious values of the displayed trace can be retrieved using the `TRAC:DATA? SPUR` command (see `TRACe<n>[:DATA]` on page 606).

2.7.3 Spurious Emissions Basics

Some background knowledge on basic terms and principles used in Spurious Emissions measurements is provided here for a better understanding of the required configuration settings.

- Ranges and Range Settings 143
- Limit Lines in Spurious Measurements 144

2.7.3.1 Ranges and Range Settings

Conditions for ranges

The following rules apply to ranges:

- The minimum span of a range is 20 Hz.
- The individual ranges must not overlap (but may have gaps).
- The maximum number of ranges is 30
- The maximum number of sweep points in all ranges is limited to 100001.

If you set a span that is smaller than the overall span of the ranges, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz.

Defining ranges by remote control

In Spurious Emissions measurements, there are no remote commands to insert new ranges between existing ranges directly. However, you can delete or re-define the existing ranges to create the required order.

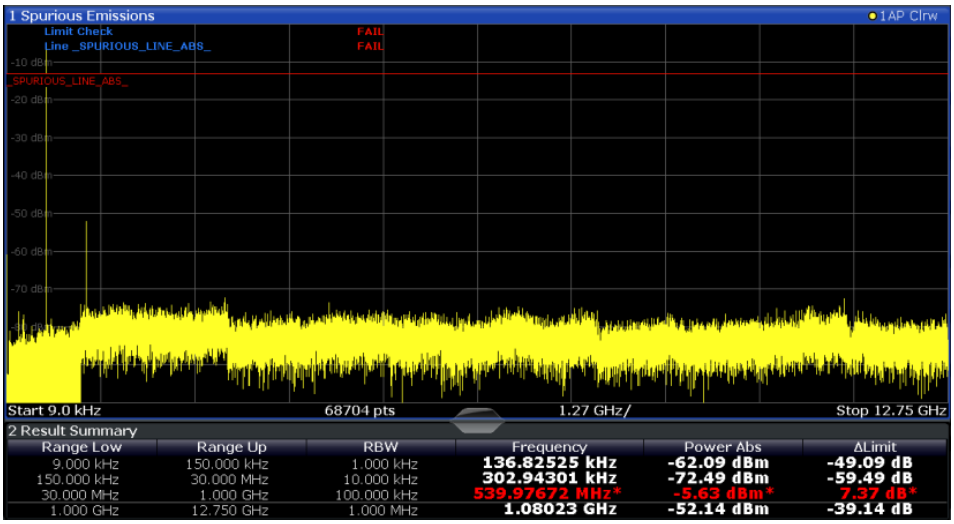
A remote command example for defining parameters and ranges in Spurious Emissions measurements is described in chapter 5.2.8.6, "Programming Example: Spurious Emissions Measurement", on page 495.

2.7.3.2 Limit Lines in Spurious Measurements

Limit lines allow you to check the measured data against specified limit values. Generally, it is possible to define limit lines for any measurement in the Spectrum application using the LINES key. For Spurious measurements, however, a special limit line is available via the "Sweep List", and it is strongly recommended that you use only this limit line definition.

In the "Sweep List" you can define a limit line that varies its level according to the specified frequency ranges. A distinguished limit line is automatically defined according to the current "Sweep List" settings every time the settings change. This limit line is labeled "_SPURIOUS_LINE_ABS_<xxx>", where <xxx> is an index to distinguish limit lines between different measurement channels.

If a limit check is activated in the "Sweep List", the "_SPURIOUS_LINE_ABS" limit line is indicated by a red line in the display, and the result of the limit check is indicated at the top of the diagram. Note that only "Pass" or "Fail" is indicated; a "margin" function as for general limit lines is not available. Also, only absolute limits can be checked, not relative ones.


1 Spurious Emissions
1AP Clrw
Limit Check FAIL
Line _SPURIOUS_LINE_ABS_ FAIL
-10 dBm
SPURIOUS_LINE_ABS_
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
Start 9.0 kHz
68704 pts
1.27 GHz/
Stop 12.75 GHz
2 Result Summary
Range Low | Range Up | RBW | Frequency | Power Abs | ΔLimit
9.000 kHz | 150.000 kHz | 1.000 kHz | 136.82525 kHz | -62.09 dBm | -49.09 dB
150.000 kHz | 30.000 MHz | 10.000 kHz | 302.94301 kHz | -72.49 dBm | -59.49 dB
30.000 MHz | 1.000 GHz | 100.000 kHz | 539.97672 MHz* | -5.63 dBm* | 7.37 dB*
1.000 GHz | 12.750 GHz | 1.000 MHz | 1.08023 GHz | -52.14 dBm | -39.14 dB

As for general limit lines, the results of each limit line check are displayed (here: "_SPURIOUS_LINE_ABS"), as well as the combined result for all defined limit lines ("Limit Check").

The limit check is considered to be "failed" if any signal level outside the absolute limits is measured.

In addition to the limit line itself, the largest deviations of the absolute power from the limit line for each range are displayed in the evaluation list if the limit check is activated. Values that exceed the limit are indicated in red and by an asterisk (*).

Although a margin functionality is not available for the limit check, a margin (threshold) for the peak values to be displayed in the evaluation list can be defined in the list evaluation settings. Furthermore, you can define how many peaks per range are listed. For details see chapter 2.7.4.3, "List Evaluation", on page 149.

2.7.4 Spurious Emissions Measurement Configuration

Spurious emissions measurements are selected via the "Spurious Emissions" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Spurious Emissions" dialog box, which is displayed when you select the "Spurious Setup" button in the "Overview" or the "Sweep List" softkey from the "Spurious Emissions" menu.

For details on using the configuration "Overview", see chapter 3.1, "Configuration Overview", on page 193.

The remote commands required to perform these tasks are described in chapter 5.2.8, "Measuring Spurious Emissions", on page 484.

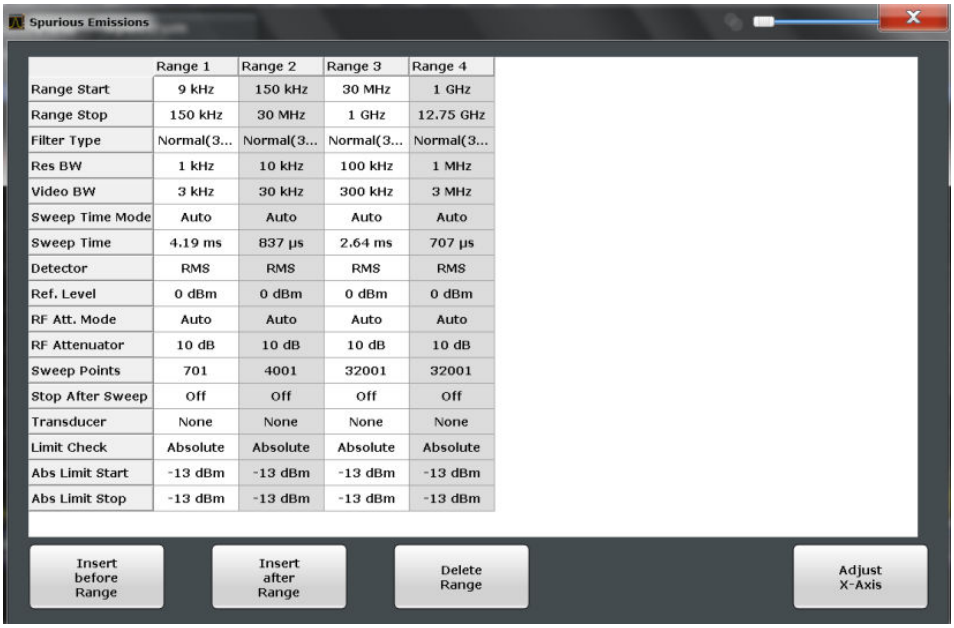
The following settings are available in individual tabs of the "Spurious Emissions" configuration dialog box, or via softkeys in the "SpurEm" menu.

- Sweep List....145
- Adjusting the X-Axis to the Range Definitions....149
- List Evaluation....149

2.7.4.1 Sweep List

For Spurious Emissions measurements, the input signal is split into several frequency ranges which are swept individually and for which different limitations apply. In the "Sweep List" dialog box you configure the individual frequency ranges and limits.

If you edit the sweep list, always follow the rules and consider the limitations described in chapter 2.7.3.1, "Ranges and Range Settings", on page 143.



Range Start / Range Stop 146
Filter Type 146
RBW 147
VBW 147
Sweep Time Mode 147
Sweep Time 147
Detector 147
Ref. Level 147
RF Att. Mode 148
RF Attenuator 148
Preamp 148
Sweep Points 148
Stop After Sweep 148
Transducer 148
Limit Check 149
Abs Limit Start/Stop 149
Insert before/after Range 149
Delete Range 149

Range Start / Range Stop
Sets the start frequency/stop frequency of the selected range.

If you set a span that is smaller than the overall span of the ranges, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz.

Remote command:
`[SENSe:]LIST:RANGe<range>[:FREQuency]:STARt` on page 488
`[SENSe:]LIST:RANGe<range>[:FREQuency]:STOP` on page 488

Filter Type
Sets the filter type for this range.

For details on filter types see chapter 3.5.1.6, "Which Data May Pass: Filter Types", on page 259.

Remote command:
`[SENSe:]LIST:RANGe<range>:FILTer:TYPE` on page 487

RBW
Sets the RBW value for this range.

For details on the RBW see chapter 3.5.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth", on page 256.

Remote command:
`[SENSe:]LIST:RANGe<range>:BANDwidth[:RESolution]` on page 486

VBW
Sets the VBW value for this range.

For details on the VBW see chapter 3.5.1.2, "Smoothing the Trace Using the Video Bandwidth", on page 256.

Remote command:
`[SENSe:]LIST:RANGe<range>:BANDwidth:VIDeo` on page 486

Sweep Time Mode
Activates or deactivates the auto mode for the sweep time.

For details on the sweep time mode see chapter 3.5.1.7, "How Long the Data is Measured: Sweep Time", on page 259

Remote command:
`[SENSe:]LIST:RANGe<range>:SWEep:TIME:AUTO` on page 492

Sweep Time
Sets the sweep time value for the range.

For details on the sweep time see chapter 3.5.1.7, "How Long the Data is Measured: Sweep Time", on page 259

Remote command:
`[SENSe:]LIST:RANGe<range>:SWEep:TIME` on page 492

Detector
Sets the detector for the range.

For details refer to chapter 4.3.1.1, "Mapping Samples to measurement Points with the Trace Detector", on page 313.

Remote command:
`[SENSe:]LIST:RANGe<range>:DETector` on page 487

Ref. Level
Sets the reference level for the range.

For details on the reference level see chapter 3.4.1.1, "Reference Level", on page 247.

Remote command:
[SENSe:]LIST:RANGe<range>:RLEVel on page 491

RF Att. Mode
Activates or deactivates the auto mode for RF attenuation.

For details on attenuation see chapter 3.4.1.2, "RF Attenuation", on page 248.

Remote command:
[SENSe:]LIST:RANGe<range>:INPut:ATTenuation:AUTO on page 489

RF Attenuator
Sets the attenuation value for that range.

For details on attenuation see chapter 3.4.1.2, "RF Attenuation", on page 248.

Remote command:
[SENSe:]LIST:RANGe<range>:INPut:ATTenuation on page 489

Preamp
Switches the preamplifier on or off.

For details on the preamplifier see "Preamplifier" on page 252.

Remote command:
[SENSe:]LIST:RANGe<range>:INPut:GAIN:STATe on page 489

Sweep Points
Sets the number of sweep points for the specified range.

For details on sweep points see chapter 3.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 260.

Remote command:
[SENSe:]LIST:RANGe<range>:POINts[:VALue] on page 491

Stop After Sweep
This command configures the sweep behavior.

"ON" The R&S FSWP stops after one range is swept and continues only if you confirm (a message box is displayed).

"OFF" The R&S FSWP sweeps all ranges in one go.

Remote command:
[SENSe:]LIST:RANGe<range>:BREak on page 486

Transducer
Sets a transducer for the specified range. You can only choose a transducer that fulfills the following conditions:

- The transducer overlaps or equals the span of the range.
- The x-axis is linear.
- The unit is dB.

For details on transducers see chapter 3.8.1, "Basics on Transducer Factors", on page 291.

Remote command:
`[SENSe:]LIST:RANGe<range>:TRANsducer` on page 492

Limit Check
Activates or deactivates the limit check for all ranges.

For details on limit checks see chapter 2.7.3.2, "Limit Lines in Spurious Measurements", on page 144.

"Absolute" Signal is checked against absolute limit values

"None" No limit check is performed.

Remote command:
`[SENSe:]LIST:RANGe<range>:LIMit:STATe` on page 490
`CALCulate<n>:LIMit<k>:FAIL?` on page 665

Abs Limit Start/Stop
Sets an absolute limit value at the start or stop frequency of the range [dBm].

Remote command:
`[SENSe:]LIST:RANGe<range>:LIMit:STARt` on page 490
`[SENSe:]LIST:RANGe<range>:LIMit:STOP` on page 491

Insert before/after Range
Inserts a new range to the left of the currently focused range (before) or to the right (after). The range numbers of the currently focused range and all higher ranges are increased accordingly. The maximum number of ranges is 30.

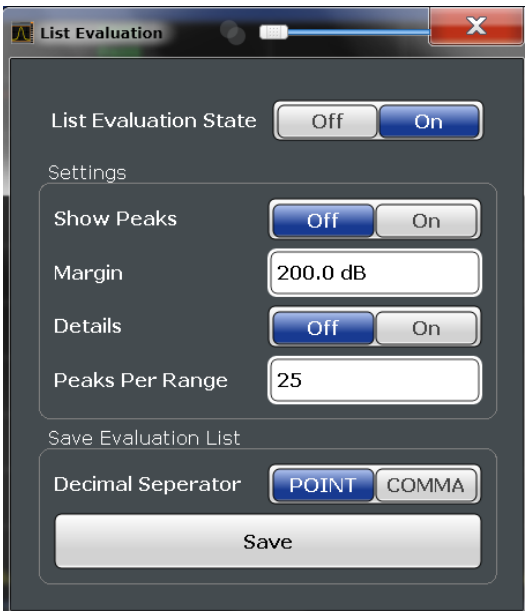
Delete Range
Deletes the currently focused range. The range numbers are updated accordingly.

2.7.4.2 Adjusting the X-Axis to the Range Definitions

The frequency axis of the measurement diagram can be adjusted automatically so that the span of all sweep list ranges corresponds to the displayed span. Thus, the x-axis range is set from the start frequency of the first sweep range to the stop frequency of the last sweep range.

2.7.4.3 List Evaluation

In the "List Evaluation" dialog box, which is displayed when you select the "Evaluations" button in the "Overview" or the "List Evaluation" softkey in the "Spurious Emissions" menu, you configure the contents and display of the result list.



List Evaluation State 150
Show Peaks 150
Margin 150
Details 150
Peaks per Range 151
Saving the Evaluation List 151

List Evaluation State
Activates or deactivates the list evaluation.

Remote command:
`CALCulate<n>:ESPectrum:PEAKsearch:AUTO` on page 480
`TRACe<n>[:DATA]` on page 606

Show Peaks
If activated, all peaks that have been detected during an active list evaluation are marked with blue squares in the diagram.

Remote command:
`CALCulate<n>:ESPectrum:PEAKsearch:PSHow` on page 480

Margin
Although a margin functionality is not available for the limit check, a margin (threshold) for the peak values to be displayed in the evaluation list (and diagram, if activated) can be defined. Only peaks that exceed the margin value are displayed.

Remote command:
`CALCulate<n>:ESPectrum:PEAKsearch:MARGin` on page 480

Details
Configures how detailed the list in the Result Summary is.

On	Includes all detected peaks (up to a maximum defined by "Peaks per Range").
Off	Includes only one peak per range.

Remote command:
CALCulate<n>:ESPectrum:PEAKsearch:DETails on page 493

Peaks per Range
Defines the maximum number of peaks per range that are stored in the list. Once the selected number of peaks has been reached, the peak search is stopped in the current range and continued in the next range. The maximum value is 50.

Remote command:
CALCulate<n>:PEAKsearch:SUBRanges on page 494

Saving the Evaluation List
Exports the evaluation list of the Spurious Emissions measurement to an ASCII file for evaluation in an external application. If necessary, change the decimal separator for evaluation in other languages.

Define the file name and storage location in the file selection dialog box that is displayed when you select the "Save" function.

For details see "How to Save the Spurious Emissions Evaluation List" on page 152.

Remote command:
MMEMory:STORe<n>:LIST on page 481
FORMat:DEXPort:DSEParator on page 615

2.7.5 How to Perform a Spurious Emissions Measurement

1. Press the MEAS key, then select the "Spurious Emissions" measurement.
2. Define the span of the signal to be monitored in the general span settings.
3. Select the "Overview" softkey, then select the "Spurious Setup" button.

   The "Spurious Emissions" dialog box is displayed.
4. Split the frequency span of the measurement into ranges for signal parts with similar characteristics.
   Define the required ranges in the "Sweep List" using the "Insert before Range" and "Insert after Range" buttons, which refer to the currently selected range.
5. Define the measurement parameters for each range as required.
6. Optionally, define a limit check.
   a) Activate the limit check by setting "Limit Check" to "Absolute". The limit check is always activated or deactivated for all ranges simultaneously.
   b) Define the limit line's start and stop values for each range of the signal. If a signal level higher than the defined limit is measured, the limit check fails, which may indicate a spurious emission.

7. Configure the peak detection during a Spurious Emissions measurement: select the "Evaluations" button in the "Overview".
   - To indicate the determined peaks in the display, activate the "Show Peaks" option.
   - To restrict peak detection, define a "Margin". Only peaks that exceed this value are detected.
   - To allow for more peaks per range to be detected than the default 1, increase the "Peaks Per Range" value and set "Details" to "On".
8. Start a sweep.

   The determined powers and limit deviations for each range are indicated in the evaluation list. If activated, the peak power levels for each range are also indicated in the diagram.
9. To save the evaluation list, export the results to a file as described in "How to Save the Spurious Emissions Evaluation List" on page 152.

How to Save the Spurious Emissions Evaluation List

The evaluation list from a Spurious Emissions measurement can be saved to a file, which can be exported to another application for further analysis, for example.

1. Configure and perform an Spurious Emissions measurement as described in chapter 2.7.5, "How to Perform a Spurious Emissions Measurement", on page 151.
2. Select the "Evaluations" button in the "Overview".
3. If necessary, change the "Decimal Separator" to "COMMA" for evaluation in other languages.
4. Select the "Save" button.
5. In the file selection dialog box, select a storage location and file name for the result file.
6. Select the "Save" button.

   The file with the specified name and the extension `.dat` is stored in the defined storage location.

2.7.6 Reference: ASCII Export File Format (Spurious)

The file has a header containing important parameters for scaling, several data sections containing the sweep settings per range, and a data section containing the peak list.

The header data is made up of three columns, separated by ';', with the syntax:

parameter name; numeric value; basic unit

File contents	Explanation
File header	
Type;FSWP-26	Model
Version;1.00;	Firmware version
Date;31.Mar 11;	Storage date of data set
Mode;ANALYZER; SPURIOUS;	Operating mode and measurement function
Center Freq;13250000000.000000;Hz	X-axis settings
Freq Offset;0.000000;Hz	
Span;26499982000.000000;Hz	
x-Axis;LIN;	
Start;9000.000000;Hz Stop;8000000000.000000;Hz	
Level Offset;0.000000;dB	Y-axis settings
Ref Position;100.000000;%	
y-Axis;LOG;	
Level Range;100.000000;dB	
Trace settings	
Trace Mode;CLR/WRITE;	
Sweep Count;1;	
TRACE 1:	
Trace Mode;CLR/WRITE;	
x-Unit;Hz;	
y-Unit;dBm;	
List evaluation settings	
Margin;6.000000;s	Peak List margin
PeaksPerRange;25;	Max. number of peaks per range to be detected
Values;3;	Number of detected peaks

File contents	Explanation
File data section	
0;9000;150000;1000;79500;-25.006643295288086;-12.006643295288086;PASS; 0;9000;150000;1000;101022.11126961483;-47.075111389160156;-34.075111389160156;PASS; 0;9000;150000;1000;58380.171184022824;-47.079341888427734;-34.079341888427734;PASS;	Measured peak values: <range number>; <start frequency>; <stop frequency>; <resolution bandwidth of range>; <frequency of peak>; <absolute power in dBm of peak>; <distance to the limit line in dB>; (positive value means above the limit) <limit fail (pass = 0, fail =1)>;

2.8 Statistical Measurements (APD, CCDF)

To measure the amplitude distribution, the R&S FSWP has simple measurement functions to determine both the Amplitude Probability Distribution (APD) and the Complementary Cumulative Distribution Function (CCDF). Only one of the signal statistic functions can be switched on at a time.

- About the Measurements 154
- Typical Applications 155
- APD and CCDF Results 155
- APD and CCDF Basics - Gated Triggering 158
- APD and CCDF Configuration 159
- How to Perform an APD or CCDF Measurement 165
- Examples 166
- Optimizing and Troubleshooting the Measurement 169

2.8.1 About the Measurements

The probability of amplitude values can be measured with the Amplitude Probability Distribution function (APD). During a selectable measurement time all occurring amplitude values are assigned to an amplitude range. The number of amplitude values in the individual ranges is counted and the result is displayed as a histogram.

Alternatively, the Complementary Cumulative Distribution Function (CCDF) can be displayed. It shows the probability that the mean signal power amplitude will be exceeded in percent.

Only one of the signal statistic functions can be switched on at a time. When a statistic function is switched on, the R&S FSWP is set into zero span mode automatically. The R&S FSWP measures the statistics of the signal applied to the RF input with the defined analysis bandwidth. To avoid affecting the peak amplitudes the video bandwidth is automatically set to 10 times the analysis bandwidth. The sample detector is used for detecting the video voltage.

Statistic measurements on pulsed signals can be performed using a gated trigger. For details see chapter 2.8.4, "APD and CCDF Basics - Gated Triggering", on page 158.

2.8.2 Typical Applications

Digital modulated signals are similar to white noise within the transmit channel, but are different in their amplitude distribution. In order to transmit the modulated signal without distortion, all amplitudes of the signal have to be transmitted linearly from the output power amplifier. Most critical are the peak amplitude values. Degradation in transmit quality caused by a transmitter two port network is dependent on the amplitude of the peak values as well as on their probability.

If modulation types are used that do not have a constant envelope in zero span, the transmitter has to handle peak amplitudes that are greater than the average power. This includes all modulation types that involve amplitude modulation, QPSK for example. CDMA transmission modes in particular may have power peaks that are large compared to the average power.

For signals of this kind, the transmitter must provide large reserves for the peak power to prevent signal compression and thus an increase of the bit error rate at the receiver. The peak power or the crest factor of a signal is therefore an important transmitter design criterion. The crest factor is defined as the peak power to mean power ratio or, logarithmically, as the peak level minus the average level of the signal. To reduce power consumption and cut costs, transmitters are not designed for the largest power that could ever occur, but for a power that has a specified probability of being exceeded (e.g. 0.01 %).

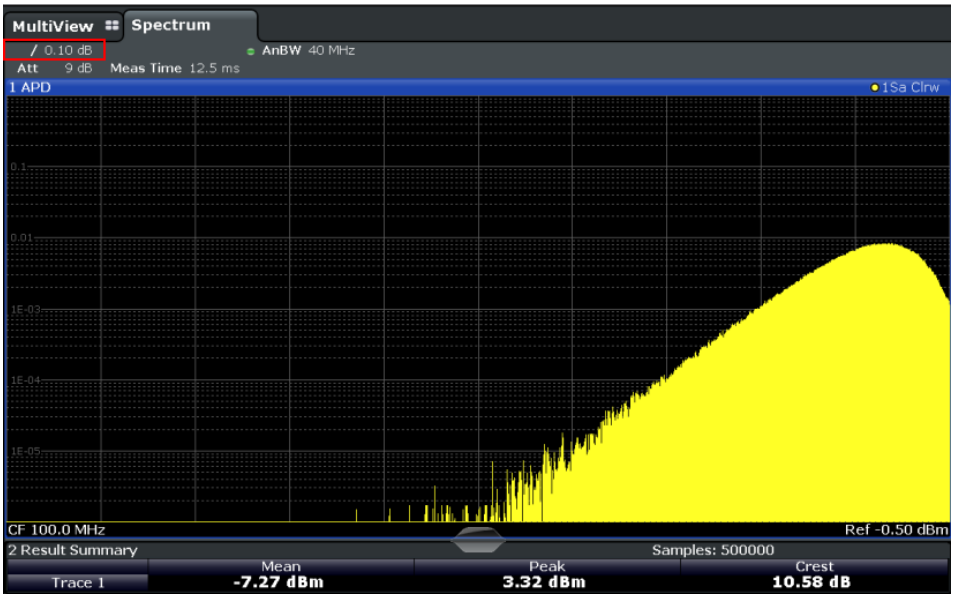
The statistical functions provide information on such signal criteria.

2.8.3 APD and CCDF Results

Amplitude Probability Distribution (APD)

As a result of the Amplitude Probability Distribution (APD) function, the probability of measured amplitude values is displayed. During a selectable measurement time all measured amplitude values are assigned to an amplitude range (*bin*). The number of amplitude values in the individual ranges is counted and the result is displayed as a histogram. Each bar of the histogram represents the percentage of measured amplitudes within the specific amplitude range. The x-axis represents the amplitude values and is scaled in absolute values (dBm).

The size of each amplitude range (bin) determines the resolution of the histogram and is indicated in the channel bar, for example */ 0.10 dB*. In this case, a single bar in the histogram represents an amplitude range of 0.10 dB.



In addition to the histogram, a result table is displayed containing the following information:

- Number of samples used for calculation
- For each displayed trace:
  - Mean amplitude
  - Peak amplitude
  - Crest factor
    The crest factor is defined as the peak power to mean power ratio or, logarithmically, as the peak level minus the average level of the signal.

Complementary Cumulative Distribution Function (CCDF)

The Complementary Cumulative Distribution Function (CCDF) shows the probability that the mean signal power amplitude will be exceeded in percent. The level above the mean power is plotted along the x-axis of the graph. The origin of the axis corresponds to the mean power level. The probability that a level will be exceeded is plotted along the y-axis.

A red line indicates the ideal Gaussian distribution for the measured amplitude range.

The displayed amplitude range is indicated as "Mean Pwr + <x dB>"

In addition to the histogram, a result table is displayed containing the following information:

- Number of samples used for calculation
- For each displayed trace:

Mean	Mean power
Peak	Peak power
Crest	Crest factor (peak power – mean power)
10 %	Level values over 10 % above mean power
1 %	Level values over 1 % above mean power
0,1 %	Level values over 0,1 % above mean power
0,01 %	Level values over 0,01 % above mean power

Percent marker

In addition to the results for specific percentages in the table, a percent marker can be activated for a freely selectable percentage. This marker indicates how many level values are over <x> % above the mean power.

Percent marker

As all markers, the percent marker can be moved simply by selecting it with a finger or mouse cursor and dragging it to the desired position.

Diagram Scaling

The scaling for both the x-axis and y-axis of the statistics diagram can be configured. In particular, you can restrict the range of amplitudes to be evaluated and the probabilities to be displayed.

Remote commands:

`CALCulate<n>:STATistics:CCDF:X<t>?` on page 503

`CALCulate<n>:STATistics:RESult<t>?` on page 504

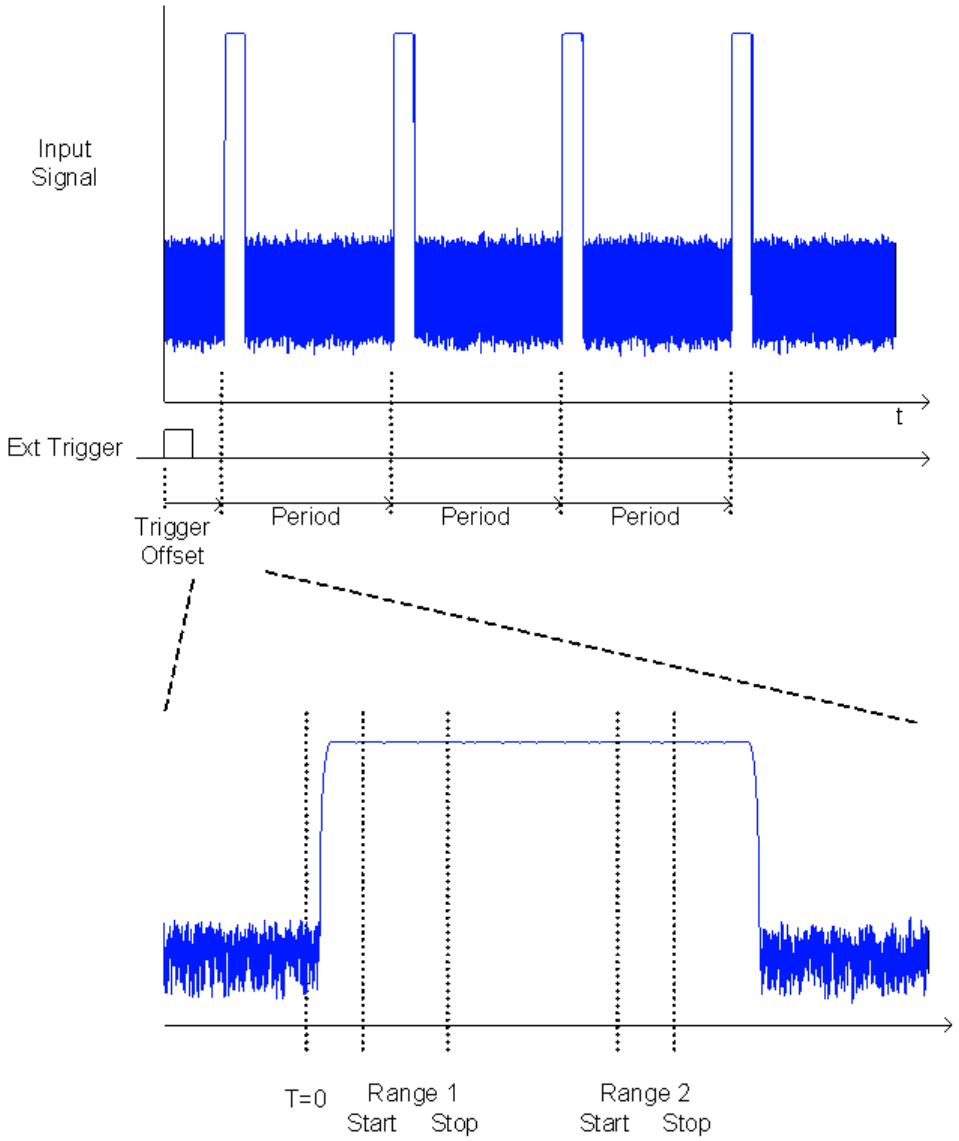
2.8.4 APD and CCDF Basics - Gated Triggering

Statistic measurements on pulsed signals can be performed using a gated trigger. An external frame trigger is required as a time (frame) reference.

The gate ranges define the part of the measured data taken into account for the statistics calculation. These ranges are defined relative to a reference point T=0. The gate interval is repeated for each period until the end of the capture buffer.

The reference point T=0 is defined by the external trigger event and the instrument's trigger offset.

For each trace you can define up to 3 separate ranges of a single period to be traced.



2.8.5 APD and CCDF Configuration

Configuration consists of the following settings:

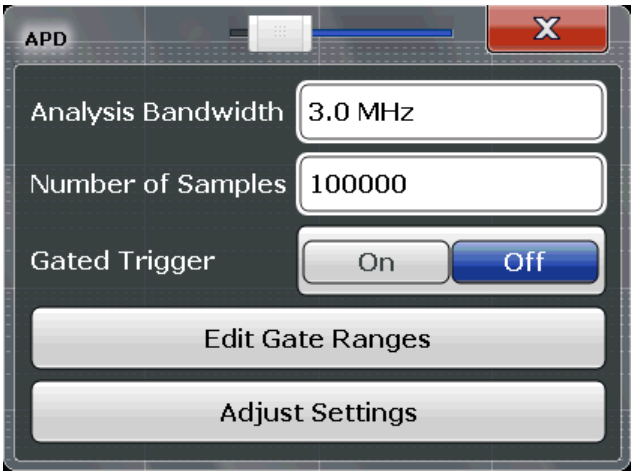
- Basic Settings 159
- Gate Range Definition for APD and CCDF 161
- Scaling for Statistics Diagrams 163

2.8.5.1 Basic Settings

APD measurements are selected via the "APD" button in the "Select Measurement" dialog box. CCDF measurements are selected via the "CCDF" button in the "Select Measurement" dialog box. The measurements are started immediately with the default settings. They can be configured via the MEAS CONFIG key or in the "APD/CCDF"

dialog boxes, which are displayed as a tab in the "Analysis" dialog box or when you select the "APD Config" softkey from the "APD" menu or the "CCDF Config" softkey from the "CCDF" menu.

The remote commands required to perform these tasks are described in chapter 5.2.9, "Analyzing Statistics", on page 497.



Both dialog boxes are identical except for the "Percent Marker" setting, which is only available for CCDF measurements.

Percent Marker (CCDF only)....160
Analysis Bandwidth....160
Number of Samples....161
Gated Trigger....161
Edit Gate Ranges....161
Adjust Settings....161

Percent Marker (CCDF only)
Defines a probability value. Thus, the power which is exceeded with a given probability can be determined very easily. If marker 1 is deactivated, it is switched on automatically.

Remote command:
`CALCulate<n>:MARKer<m>:Y:PERCent` on page 498

Analysis Bandwidth
Defines the analysis bandwidth.

For correct measurement of the signal statistics, the analysis bandwidth has to be wider than the signal bandwidth in order to measure the peaks of the signal amplitude correctly. To avoid influencing the peak amplitudes, the video bandwidth is automatically set to 10 MHz. The sample detector is used for detecting the video voltage.

The calculated measurement time is displayed for reference only.

Remote command:
`[SENSe:]BANDwidth[:RESolution]` on page 581

Number of Samples
Defines the number of power measurements that are taken into account for the statistics.

For statistics measurements with the R&S FSWP, the number of samples to be measured is defined instead of the sweep time. Since only statistically independent samples contribute to statistics, the sweep or measurement time is calculated automatically and displayed in the channel bar ("Meas Time"). The samples are statistically independent if the time difference is at least 1/RBW. The measurement time is, therefore, expressed as follows:

Meas Time = $N_{Samples}$/RBW

Remote command:
`CALCulate<n>:STATistics:NSAMples` on page 498

Gated Trigger
Activates and deactivates gating for statistics functions for the ACP and the CCDF measurements. If activated, the trigger source is changed to "External Trigger 1". The gate ranges are defined using the Edit Gate Ranges function.

Remote command:
`[SENSe:]SWEep:EGATe:TRACe<k>[:STATe<range>]` on page 500

Edit Gate Ranges
Opens a dialog box to configure up to 3 gate ranges for each trace. For details see chapter 2.8.5.2, "Gate Range Definition for APD and CCDF", on page 161.

Adjust Settings
Adjusts the level settings according to the measured difference between peak and minimum power for APD measurement or peak and mean power for CCDF measurement in order to obtain maximum power resolution. Adjusts the reference level to the current input signal.

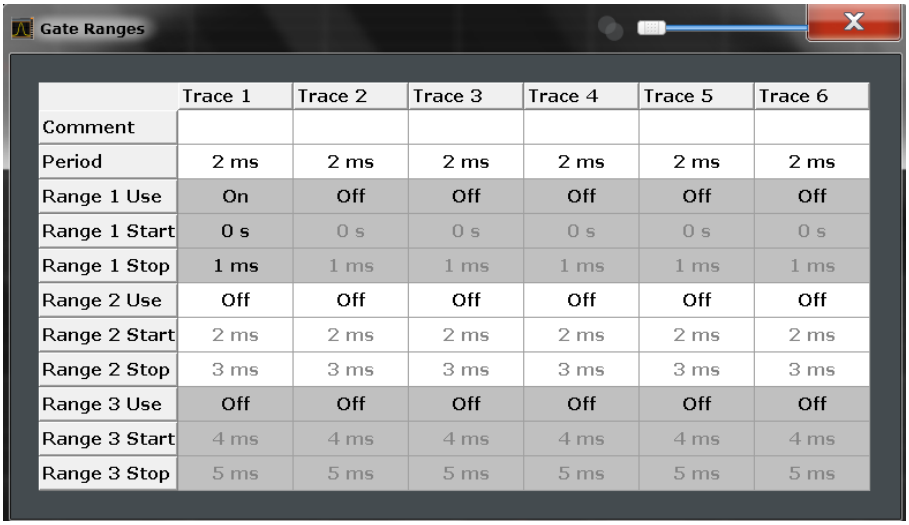
Remote command:
`CALCulate<n>:STATistics:SCALe:AUTO ONCE` on page 501

2.8.5.2 Gate Range Definition for APD and CCDF

Gate ranges for gated triggering in statistical measurements can be configured in the "Gate Ranges" dialog box, which is displayed when you select the "Edit Gate Ranges" button in the "APD" or "CCDF" configuration dialog boxes.

For background information on defining gate ranges see chapter 2.8.4, "APD and CCDF Basics - Gated Triggering", on page 158.

The remote commands required to perform these tasks are described in chapter 5.2.9.3, "Using Gate Ranges for Statistical Measurements", on page 499.



	Trace 1	Trace 2	Trace 3	Trace 4	Trace 5	Trace 6
Comment						
Period	2 ms	2 ms	2 ms	2 ms	2 ms	2 ms
Range 1 Use	On	Off	Off	Off	Off	Off
Range 1 Start	0 s	0 s	0 s	0 s	0 s	0 s
Range 1 Stop	1 ms	1 ms	1 ms	1 ms	1 ms	1 ms
Range 2 Use	Off	Off	Off	Off	Off	Off
Range 2 Start	2 ms	2 ms	2 ms	2 ms	2 ms	2 ms
Range 2 Stop	3 ms	3 ms	3 ms	3 ms	3 ms	3 ms
Range 3 Use	Off	Off	Off	Off	Off	Off
Range 3 Start	4 ms	4 ms	4 ms	4 ms	4 ms	4 ms
Range 3 Stop	5 ms	5 ms	5 ms	5 ms	5 ms	5 ms

Up to three ranges can be defined for each of the six available traces.

Comment....162
Period....162
Range <x> Use....162
Range <x> Start/Stop....162

Comment
An optional comment can be defined for the gate range settings of each trace.

Remote command:
`[SENSe:]SWEep:EGATe:TRACe<k>:COMMent` on page 499

Period
Length of the period to be traced. The period is the same for all traces. If you change the period for one trace, it is automatically changed for all traces.

Make sure the defined period is not longer than the total measurement time of the current measurement. Keep in mind that the measurement time depends on the bandwidth and the number of samples (see "Number of Samples" on page 161). The current measurement time is indicated as "Meas Time" in the channel bar.

Remote command:
`[SENSe:]SWEep:EGATe:TRACe:PERiod` on page 499

Range <x> Use
Activates tracing of the defined range during a gated measurement.

Remote command:
`[SENSe:]SWEep:EGATe:TRACe<k>[:STATe<range>]` on page 500

Range <x> Start/Stop
Defines the start and stop points of the range within the tracing period. Make sure the value for the stopping time is smaller than the length of the period.

Note: You can define the time values with a greater numerical resolution than is displayed; the values are only rounded for display.

Remote command:
`[SENSe:]SWEep:EGATe:TRACe<k>:STARt<range>` on page 499
`[SENSe:]SWEep:EGATe:TRACe<k>:STOP<range>` on page 500

2.8.5.3 Scaling for Statistics Diagrams

The diagram scaling for statistical measurements can be configured in the "Scaling" dialog box, which is displayed when you select the AMPT key and then the "Scale Config" softkey.

The remote commands required to perform these tasks are described in chapter 5.2.9.4, "Scaling the Diagram", on page 501.

In statistical diagrams, the x-axis displays the signal level values (= y-axis in standard display), while the y-axis displays the probability of the values.

X-Axis 164
└ Range 164
└ Ref Level 164
└ Shifting the Display (Offset) 164
Y-Axis 164
└ Y-Unit 164
└ Y-Max / Y-Min 164
Default Settings 164
Adjust Settings 165

X-Axis
Defines the scaling settings for signal level values.

Range ← X-Axis
Defines the level range in dB to be evaluated by the statistics measurement.

Remote command:
CALCulate<n>:STATistics:SCALe:X:RANGe on page 502

Ref Level ← X-Axis
Defines the reference level for the signal levels in the currently active unit (dBm, dBµV, etc).

For the APD function this value corresponds to the right diagram border. For the CCDF function there is no direct representation of this value on the diagram as the x-axis is scaled relatively to the measured mean power.

Remote command:
CALCulate<n>:STATistics:SCALe:X:RLEVel on page 502

Shifting the Display (Offset) ← X-Axis
Defines an arithmetic level offset. This offset is added to the measured level irrespective of the selected unit. The scaling of the x-axis is changed accordingly. The setting range is ±200 dB in 0.1 dB steps.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet on page 576

Y-Axis
Defines the scaling settings for the probability distribution.

Y-Unit ← Y-Axis
Defines the scaling type of the y-axis as either percentage or absolute. The default value is absolute scaling.

Remote command:
CALCulate<n>:STATistics:SCALe:Y:UNIT on page 503

Y-Max / Y-Min ← Y-Axis
Defines the upper (max) and lower (min) limit of the displayed probability range. Values on the y-axis are normalized which means that the maximum value is 1.0. The minimum value must be in the range:

1E-9 < Y-Min < 0.1

The distance between Y-max and Y-min must be at least one decade.

Remote command:
CALCulate<n>:STATistics:SCALe:Y:UPPer on page 503
CALCulate<n>:STATistics:SCALe:Y:LOWer on page 502

Default Settings
Resets the x- and y-axis scalings to their preset values.

x-axis ref level:	-10 dBm
x-axis range APD:	100 dB
x-axis range CCDF:	20 dB
y-axis upper limit:	1.0
y-axis lower limit:	1E-6

Remote command:
`CALCulate<n>:STATistics:PRESet` on page 501

Adjust Settings
Adjusts the level settings according to the measured difference between peak and minimum power for APD measurement or peak and mean power for CCDF measurement in order to obtain maximum power resolution. Adjusts the reference level to the current input signal.

Remote command:
`CALCulate<n>:STATistics:SCALe:AUTO ONCE` on page 501

2.8.6 How to Perform an APD or CCDF Measurement

To start a basic statistic measurement

1. Press the MEAS key, then select the "APD" or "CCDF" measurement.
2. Start a sweep.

   As soon as the defined number of samples have been measured, the statistical evaluation is displayed.

To perform a statistic measurement using gate ranges

For pulsed signals, the transmission intervals should not be included in the statistical evaluation. Thus, you must define gate ranges to be included in the measurement.

1. Press the MEAS CONFIG key, then select the "APD Config" or "CCDF Config" softkey.

   The "APD" or "CCDF" dialog box is displayed.
2. Select the "Edit Gate Ranges" button.
3. Define the time period for which the input signal is to be analyzed, for example the duration of 3 signal pulses.
4. For each active trace, define up to three ranges within the time period to be measured. In the example covering 3 pulses, you could define one range for each pulse.

   a) Assuming the external trigger determines T=0 as the start of the first pulse, define the start time of range 1 at 0 s.

b) Define the stop time of range 1 at the duration of the first pulse.
c) Activate range 1 by setting "Range 1 Use" to *On*.
d) Define the start time of range 2 as (duration of pulse 1 + duration of interval)
e) Define the stop time of range 2 as (start time of range 2 + duration of pulse 2)
f) Activate range 2 by setting "Range 2 Use" to *On*.
g) Define the third range in the same way.

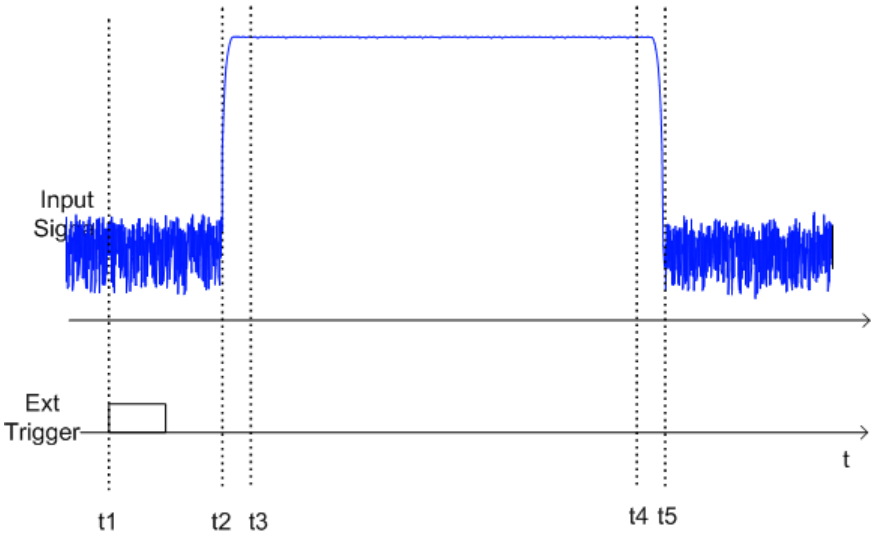
5. Start a sweep.

   As soon as the defined number of samples have been measured, the statistical evaluation is displayed. Only the signal levels within the pulse periods are considered.

2.8.7 Examples

2.8.7.1 Configuration Example: Gated Statistics

A statistics evaluation has to be done over the useful part of the signal between t3 and t4. The period of the GSM signal is 4.61536 ms.



t1: External positive trigger slope

t2: Begin of burst (after 25 µs)

t3: Begin of useful part, to be used for statistics (after 40 µs)

t4: End of useful part, to be used for statistics (after 578 µs)

t5: End of burst (after 602 µs)

The instrument has to be configured as follows:

Trigger Offset	t2 – t1 = 25 µs	now the gate ranges are relative to t2
Range1 Start	t3 – t2 = 15 µs	start of range 1 relative to t2
Range1 End	t4 – t2 = 553 µs	end of range 1 relative to t2

2.8.7.2 Measurement Example – Measuring the APD and CCDF of White Noise Generated by the R&S FSWP

Setting the RBW

When the amplitude distribution is measured, the analysis bandwidth must be set so that the complete spectrum of the signal to be measured falls within the bandwidth. This is the only way of ensuring that all the amplitudes will pass through the IF filter without being distorted. If the selected bandwidth is too small for a digitally modulated signal, the amplitude distribution at the output of the IF filter becomes a Gaussian distribution according to the central limit theorem and thus corresponds to a white noise signal. The true amplitude distribution of the signal therefore cannot be determined.

1. Preset the R&S FSWP.
2. Set the reference level to *-60 dBm*.

   The R&S FSWP's intrinsic noise is displayed at the top of the screen.
3. Select the "APD" measurement function from the "Select Measurement" dialog box.

   The R&S FSWP sets the frequency span to 0 Hz and measures the amplitude probability distribution (APD). The number of uncorrelated level measurements used for the measurement is 100000. The mean power and the peak power are displayed in dBm. The crest factor (peak power – mean power) is output as well.

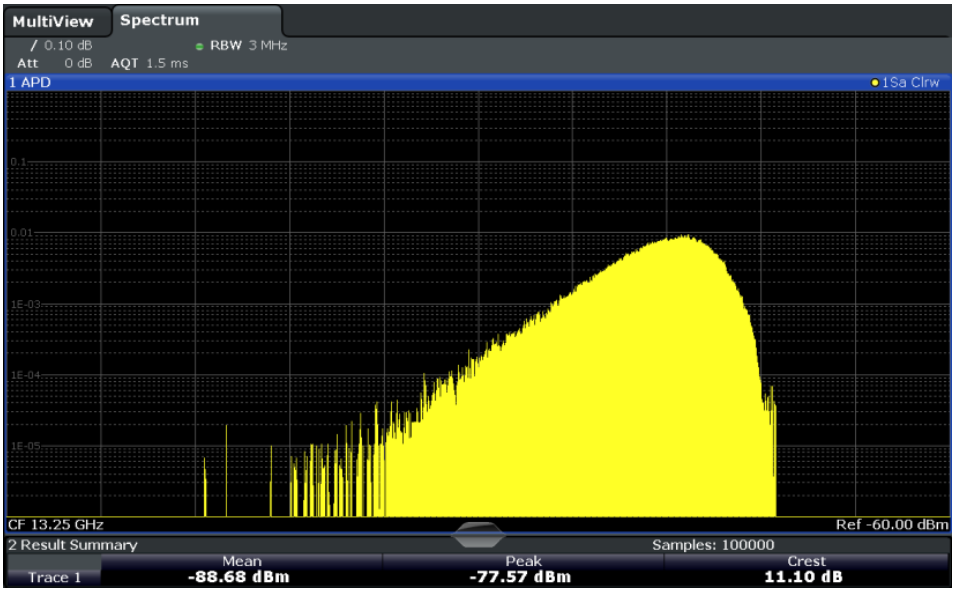


Fig. 2-39: Amplitude probability distribution of white noise

4. Now select the "CCDF" measurement function from the "Select Measurement" dialog box.

Fig. 2-40: CCDF of white noise

The CCDF trace indicates the probability that a level will exceed the mean power. The level above the mean power is plotted along the x-axis of the graph. The origin of the axis corresponds to the mean power level. The probability that a level will be exceeded is plotted along the y-axis.

2.8.8 Optimizing and Troubleshooting the Measurement

If the results do not meet your expectations, try the following methods to optimize the measurement:

- Make sure the defined bandwidth is wide enough for the signal bandwidth of the device under test to be fully analyzed (see "Analysis Bandwidth" on page 160).
- If the complete signal is be measured, increase the number of samples so that the resulting measurement time is longer than one period of a bursted signal.
- If only parts of the signal are to be examined, define a trigger source and a gate.

2.9 Time Domain Power Measurement

The R&S FSWP can determine the power of a signal in the time domain using the Time Domain Power measurement function.

- About the Measurement....169
- Time Domain Power Results....169
- Time Domain Power Basics - Range Definition Using Limit Lines....170
- Time Domain Power Configuration....171
- How to Measure Powers in the Time Domain....172
- Measurement Example....172

2.9.1 About the Measurement

Using the Time Domain Power measurement function, the R&S FSWP determines the power of the signal in zero span by summing up the power at the individual measurement points and dividing the result by the number of measurement points. Thus it is possible to measure the power of TDMA signals during transmission, for example, or during the muting phase. Both the mean power and the RMS power can be measured.

For this measurement, the sample detector is activated.

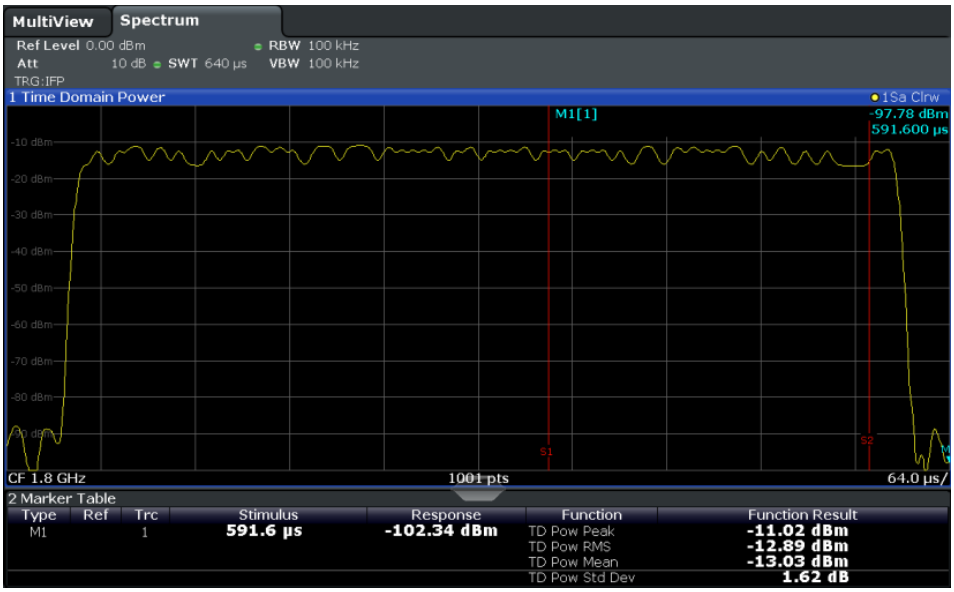
2.9.2 Time Domain Power Results

Several different power results can be determined simultaneously:

Mode	Description
Peak	Peak value from the points of the displayed trace or a segment thereof.
RMS	RMS value from the points of the displayed trace or a segment thereof.

Mode	Description
Mean	Mean value from the points of the displayed trace or a segment thereof. The linear mean value of the equivalent voltages is calculated. For example to measure the mean power during a GSM burst
Std Dev	The standard deviation of the measurement points from the mean value.

The result is displayed in the marker results, indicated by "Power" and the selected power mode, e.g. "RMS". The measured values are updated after each sweep or averaged over a user-defined number of sweeps (trace averaging).



The results can also be queried using the remote commands described in chapter 5.2.10, "Measuring the Time Domain Power", on page 506.

2.9.3 Time Domain Power Basics - Range Definition Using Limit Lines

The range of the measured signal to be evaluated for the power measurement can be restricted using limit lines. The left and right limit lines (S1, S2) define the evaluation range and are indicated by vertical red lines in the diagram. If activated, the power results are only calculated from the levels within the limit lines.

For example, if both the on and off phase of a burst signal are displayed, the measurement range can be limited to the transmission or to the muting phase. The ratio between signal and noise power of a TDMA signal for instance can be measured by using a measurement as a reference value and then varying the measurement range.

In order to get stable measurement results for a limited evaluation range, usually a trigger is required.

2.9.4 Time Domain Power Configuration

Time Domain Power measurements are selected via the "Time Domain Power" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Time Domain Power" dialog box, which is displayed as a tab in the "Analysis" dialog box or when you select the "Time Dom Power Config" softkey from the "Time Dom Pwr" menu.

The remote commands required to perform these tasks are described in chapter 5.2.10.1, "Configuring the Measurement", on page 506.

Results 171
Limit State 171
Left Limit / Right Limit 172

Results
Activates the power results to be evaluated from the displayed trace or a limited area of the trace.

"Peak"	Peak power over several measurements (uses trace averaging, Max Hold)
"RMS"	RMS value from the points of the displayed trace or a segment thereof.
"Mean"	Mean value from the points of the displayed trace or a segment thereof. The linear mean value of the equivalent voltages is calculated.
"Std Dev"	The standard deviation of the measurement points from the mean value. The measurement of the mean power is automatically switched on at the same time.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak[:STATe]` on page 508
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:RESult?` on page 510
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS[:STATe]` on page 508
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:RESult?` on page 511
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN[:STATe]` on page 508
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:RESult?` on page 509

Limit State
Switches the limitation of the evaluation range on or off. Default setting is off.

If deactivated, the entire sweep time is evaluated. If switched on, the evaluation range is defined by the left and right limit. If only one limit is set, it corresponds to the left limit and the right limit is defined by the stop frequency. If the second limit is also set, it defines the right limit.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 632

Left Limit / Right Limit
Defines a power level limit for line S1 (left) or S2 (right).

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 631
`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT` on page 632

2.9.5 How to Measure Powers in the Time Domain

To measure the power in the time domain

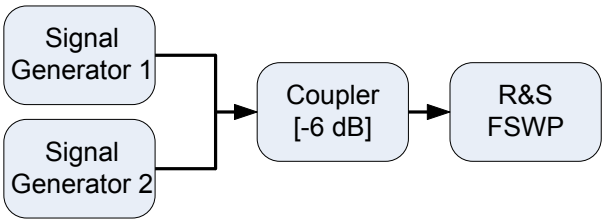
1. Select the "Time Domain Power" measurement function from the "Select Measurement" dialog box.
2. Select the type of power measurement results to be determined by selecting the corresponding softkeys.
3. To restrict the power evaluation range, define limits:
   a) Select the "Time Dom Power Config" softkey to display the "Time Domain Power" configuration dialog box.
   b) Switch on the limits by setting the "Limit State" to "On".
   The limit lines S1 and S2 are displayed.
   c) Define the left limit (limit line S1), the right limit (S2), or both.
4. Start a sweep.

   The measured powers are displayed in the marker results.

2.9.6 Measurement Example

This measurement example demonstrates the time domain power calculation for a GSM burst.

Test setup:



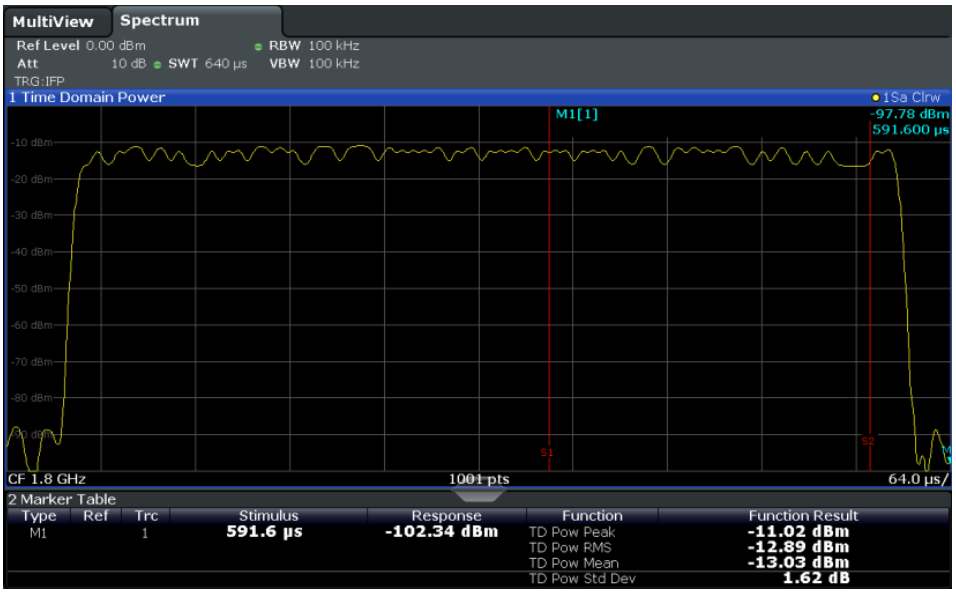
Signal generator settings (e.g. R&S FSWP SMW):

Frequency:	1.8 GHz
Level:	-10 dBm
Modulation:	GSM/EDGE

Procedure:

1. Preset the R&S FSWP.
2. Set the center frequency to *1.8 GHz*.
3. Set the RBW to *100 kHz*.
4. Set the sweep time to *640 µs*.
5. Set the trigger source to "IF Power".
6. Define a trigger offset of *-50 µs*.
7. Select the "Time Domain Power" measurement function from the "Select Measurement" dialog box.
8. In the Time Domain Power configuration dialog box, set all four results to "ON".
9. Set the "Limit State" to "ON".
10. Define the left limit at *326 µs* and the right limit at *538 µs*.
    This range corresponds to the useful part of the GSM burst.

    The mean power of the useful part of the GSM burst is calculated to be -13 dBm.



2.10 Harmonic Distortion Measurement

The harmonics and their distortion can be measured using the "Harmonic Distortion" function.

- About the Measurement....174
- Harmonic Distortion Basics....174
- Harmonic Distortion Results....177
- Harmonic Distortion Configuration....177
- How to Determine the Harmonic Distortion....179

2.10.1 About the Measurement

With this measurement it is possible to measure the harmonics easily, for example from a VCO. In addition, the total harmonic distortion (THD) is calculated.

For measurements in the frequency domain, the Harmonic Distortion measurement starts with an automatic search for the first harmonic (= peak) within the set frequency range. The center frequency is set to this frequency and the reference level is adjusted accordingly.

For measurements in zero span, the center frequency remains unchanged.

The Harmonic Distortion measurement then performs zero span sweeps at the center frequency and at each harmonic, i.e. at frequencies that are a multiple of the center frequency.

As a result, the zero span sweeps on all harmonics are shown, as well as the RMS values and the total harmonic distortion (THD).

2.10.2 Harmonic Distortion Basics

Measuring the harmonics of a signal is a frequent problem which can be solved best using a signal analyzer. In general, every signal contains harmonics. Harmonics are generated by nonlinear characteristics, which add frequencies to a pure sinewave. They can often be reduced by low pass filters. Since the signal analyzer itself has a nonlinear characteristic, for example in its first mixer, measures must be taken to ensure that harmonics produced in the signal analyzer do not cause spurious results. If necessary, the fundamental wave must be attenuated selectively with respect to the other harmonics with a high pass filter. Harmonics are particularly critical regarding high-power transmitters such as transceivers because large harmonics can interfere with other radio services.

Harmonic distortion can be determined as the level of the individual components, or as the root mean square of all components together, the total harmonic distortion (THD). The THD is set in relation to the power of the fundamental frequency (= center frequency).

Obtainable dynamic range

When harmonics are being measured, the obtainable dynamic range depends on the second harmonic intercept of the signal analyzer. The second harmonic intercept is the virtual input level at the RF input mixer at which the level of the 2nd harmonic becomes equal to the level of the fundamental wave. In practice, however, applying a level of this magnitude would damage the mixer. Nevertheless the available dynamic range for

measuring the harmonic distance of a DUT can be calculated relatively easily using the second harmonic intercept.

As shown in figure 2-41, the level of the 2nd harmonic drops by 20 dB if the level of the fundamental wave is reduced by 10 dB.

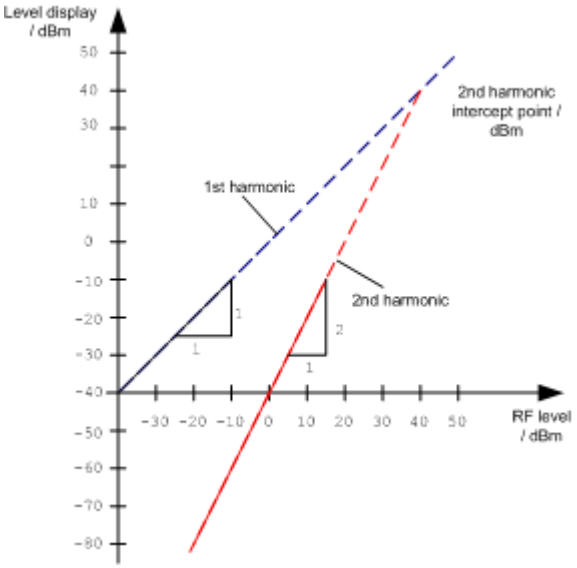


Fig. 2-41: Extrapolation of the 1st and 2nd harmonics to the 2nd harmonic intercept at 40 dBm

The following formula for the obtainable harmonic distortion d_2 in dB is derived from the straight-line equations and the given intercept point:

$d_2 = S.H.I – P_I$ (1)

where:

d_2	=	harmonic distortion
S.H.I.	=	second harmonic intercept
P_I	=	mixer level/dBm

The mixer level is the RF level applied to the RF input minus the set RF attenuation.

The formula for the internally generated level P_1 at the 2nd harmonic in dBm is:

$P_1 = 2 * P_I – S.H.I.$ (2)

The lower measurement limit for the harmonic is the noise floor of the signal analyzer. The harmonic of the measured DUT should – if sufficiently averaged by means of a video filter – be at least 4 dB above the noise floor so that the measurement error due to the input noise is less than 1 dB.

Rules for measuring high harmonic ratios

The following rules for measuring high harmonic ratios can be derived:

- Select the smallest possible IF bandwidth for a minimal noise floor.
- Select an RF attenuation which is high enough to measure the harmonic ratio only.

The maximum harmonic distortion is obtained if the level of the harmonic equals the intrinsic noise level of the receiver. The level applied to the mixer, according to (2), is:

$$P_I = \frac{P_{noise} / dBm + IP2}{2}$$

At a resolution bandwidth of 10 Hz (noise level -143 dBm, S.H.I. = 40 dBm), the optimum mixer level is – 51.5 dBm. According to (1) a maximum measurable harmonic distortion of 91.5 dB minus a minimum S/N ratio of 4 dB is obtained.

Detecting the origin of harmonics

If the harmonic emerges from noise sufficiently (approx. >15 dB), it is easy to check (by changing the RF attenuation) whether the harmonics originate from the DUT or are generated internally by the signal analyzer. If a harmonic originates from the DUT, its level remains constant if the RF attenuation is increased by 10 dB. Only the displayed noise is increased by 10 dB due to the additional attenuation. If the harmonic is exclusively generated by the signal analyzer, the level of the harmonic is reduced by 20 dB or is lost in noise. If both – the DUT and the signal analyzer – contribute to the harmonic, the reduction in the harmonic level is correspondingly smaller.

High-sensitivity harmonics measurements

If harmonics have very small levels, the resolution bandwidth required to measure them must be reduced considerably. The sweep time is, therefore, also increased considerably. In this case, the measurement of individual harmonics is carried out with the R&S FSWP set to a small span. Only the frequency range around the harmonics will then be measured with a small resolution bandwidth.

Required measurement time

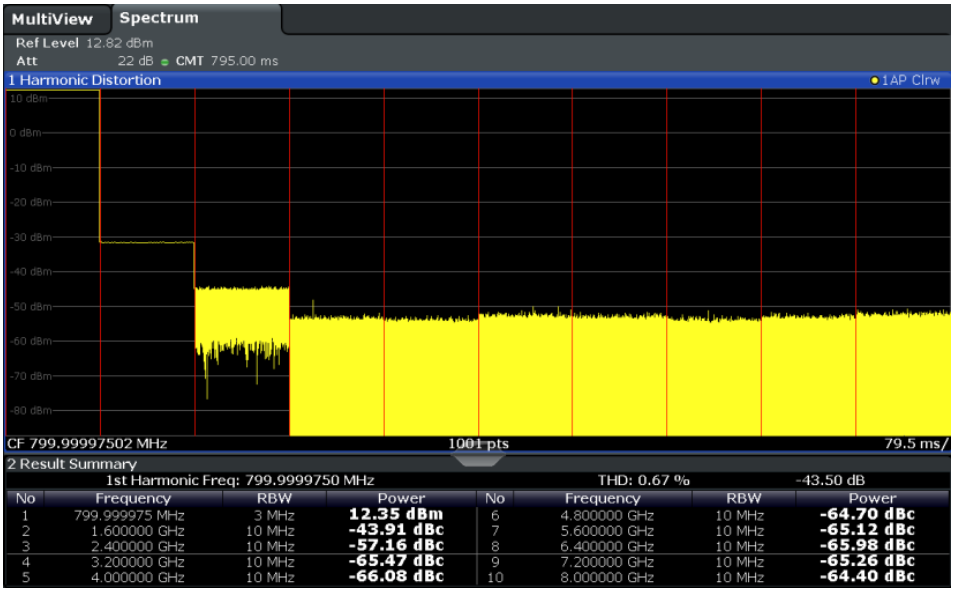
During the harmonics measurement, zero span sweeps are performed at the center frequency and at each harmonic. The duration of each sweep ("Harmonic Sweep Time", **SWT**) and the "Number of Harmonics" (n) are defined in the "Harmonic Distortion" configuration dialog box. Thus, the required measurement time for the harmonic distortion measurement (*Cumulated Measurement Time*, **CMT**) is:

*CMT = n*SWT*

The required measurement time is indicated as "CMT" in the channel bar.

2.10.3 Harmonic Distortion Results

As a result of the harmonics distortion measurement, the zero span sweeps of all detected harmonics are shown in the diagram, separated by red display lines. This provides a very good overview of the measurement.


MultiView
Spectrum
Ref Level 12.82 dBm
Att 22 dB CMT 795.00 ms
1 Harmonic Distortion
1AP Clrw
CF 799.99997502 MHz
1001 pts
79.5 ms/
2 Result Summary
1st Harmonic Freq: 799.9999750 MHz
THD: 0.67 %
-43.50 dB
No Frequency RBW Power
1 799.999975 MHz 3 MHz 12.35 dBm
2 1.600000 GHz 10 MHz -43.91 dBc
3 2.400000 GHz 10 MHz -57.16 dBc
4 3.200000 GHz 10 MHz -65.47 dBc
5 4.000000 GHz 10 MHz -66.08 dBc
6 4.800000 GHz 10 MHz -64.70 dBc
7 5.600000 GHz 10 MHz -65.12 dBc
8 6.400000 GHz 10 MHz -65.98 dBc
9 7.200000 GHz 10 MHz -65.26 dBc
10 8.000000 GHz 10 MHz -64.40 dBc

In addition, a result table is displayed providing the following information:

- First harmonic frequency
- THD (total harmonic distortion), relative and absolute values
- For each detected harmonic:
  - Frequency
  - RBW
  - Power

Remote commands

The results can also be queried using remote commands.

The first harmonic frequency can be read out via the general center frequency command `[SENSe:]FREQuency:CENTer` on page 570.

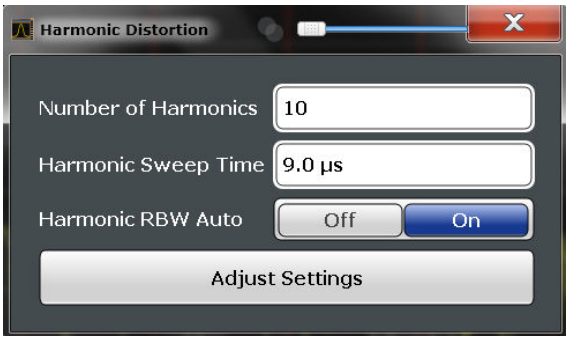
THD: `CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:DISTortion?` on page 516

List of harmonics: `CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:LIST?` on page 516

2.10.4 Harmonic Distortion Configuration

Harmonic Distortion measurements are selected via the "Harmonic Distortion" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Har-

monic Distortion" dialog box, which is displayed as a tab in the "Analysis" dialog box or when you select the "Harmonic Distortion Config" softkey from the "Harm Dist" menu.



The remote commands required to perform these tasks are described in chapter 5.2.11, "Measuring the Harmonic Distortion", on page 514.

No. of Harmonics 178
Harmonic Sweep Time 178
Harmonic RBW Auto 178
Adjust Settings 179

No. of Harmonics
Defines the number of harmonics to be measured. The range is from 1 to 26. Default is 10.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:NHARmonics` on page 515

Harmonic Sweep Time
Defines the sweep time for the zero span measurement on each harmonic frequency. This setting is identical to the normal sweep time for zero span, see also "Sweep Time" on page 263.

Remote command:
`[SENSe:]SWEep:TIME:AUTO` on page 588

Harmonic RBW Auto
Enables/disables the automatic adjustment of the resolution bandwidth for Normal (3dB) (Gaussian) and 5-Pole filter types. The automatic adjustment is carried out according to:

"$RBW_n = RBW_1 * n$"

If RBW_n is not available, the next higher value is used.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:BANDwidth:AUTO` on page 515

Adjust Settings
If harmonic measurement was performed in the frequency domain, a new peak search is started in the frequency range that was set before starting the harmonic measurement. The center frequency is set to this frequency and the reference level is adjusted accordingly.

If harmonic measurement was performed in the time domain, this function adjusts the reference level only.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:PRESet` on page 515

2.10.5 How to Determine the Harmonic Distortion

In chapter 4.4.6, "Measurement Example: Measuring Harmonics Using Marker Functions", on page 380, measuring harmonics was described using marker functions. This task can be performed much simpler using the Harmonic Distortion measurement, as described in the following procedure.

1. Select the "Harmonic Distortion" measurement function from the "Select Measurement" dialog box.
2. Define the number of harmonics to be determined using the "No. of Harmonics" softkey.
3. Perform a sweep.

   The trace for the determined harmonics are displayed in the diagram, separated by red display lines. The measured power for each harmonic in relation to the fundamental is indicated in the result table.
4. If the signal changes significantly during or after the harmonics measurement, use the "Adjust Settings" function to adjust the settings automatically and restart the measurement.

2.11 Third Order Intercept (TOI) Measurement

The third order intercept point of the R&S FSWP can be determined if a two-tone signal with equal carrier levels is applied to the input.

- About the TOI Measurement....180
- TOI Basics....180
- TOI Results....184
- TOI Configuration....185
- How to Determine the Third Order Intercept....186
- Measurement Example – Measuring the R&S FSWP's Intrinsic Intermodulation....187

2.11.1 About the TOI Measurement

If several signals are applied to a transmission two-port device with nonlinear characteristic, intermodulation products appear at its output at the sums and differences of the signals. The nonlinear characteristic produces harmonics of the useful signals which intermodulate at the characteristic. The intermodulation products of lower order have a special effect since their level is largest and they are near the useful signals. The intermodulation product of third order causes the highest interference. It is the intermodulation product generated from one of the useful signals and the 2nd harmonic of the second useful signal in case of two-tone modulation.

In order to measure the third order intercept point (TOI), a two-tone signal with equal carrier levels is expected at the R&S FSWP input. Marker 1 and marker 2 (both normal markers) are set to the maximum of the two signals. Marker 3 and marker 4 are placed on the intermodulation products.

The R&S FSWP calculates the third order intercept point from the level difference between the first 2 markers and the markers 3 and 4 and displays it in the marker field.

2.11.2 TOI Basics

If several signals are applied to a transmission two-port device with nonlinear characteristic, intermodulation products appear at its output at the sums and differences of the signals. The nonlinear characteristic produces harmonics of the useful signals which intermodulate at the characteristic.

The frequencies of the intermodulation products are above and below the useful signals. The figure 2-42 shows intermodulation products P_{S1} and P_{S2} generated by the two useful signals P_{U1} and P_{U2}.

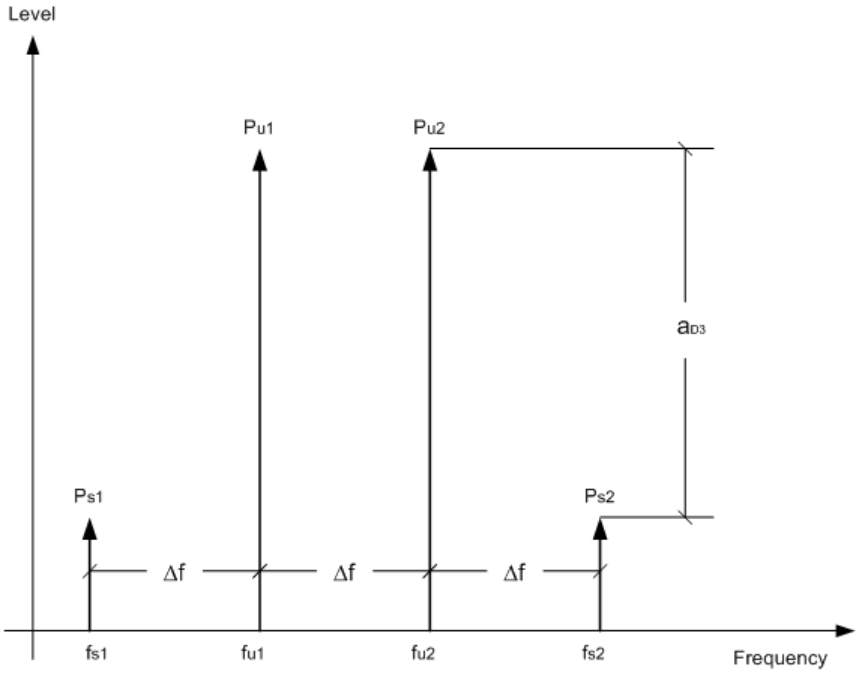


Fig. 2-42: Intermodulation products Ps1 and Ps2

The intermodulation product at f_{i2} is generated by mixing the 2nd harmonic of useful signal P_{U2} and signal P_{U1}.

Tthe intermodulation product at f_{i1} is generated by mixing the 2nd harmonic of useful signal P_{U1} and signal P_{U2}.

$f_{i1} = 2 \times f_{u1} - f_{u2}$ (1)

$f_{i2} = 2 \times f_{u2} - f_{u1}$ (2)

Dependency on level of useful signals

The level of the intermodulation products depends on the level of the useful signals. If the two useful signals are increased by 1 dB, the level of the intermodulation products increases by 3 dB, which means that the spacing a_{D3} between intermodulation signals and useful signals is reduced by 2 dB. This is illustrated in figure 2-43.

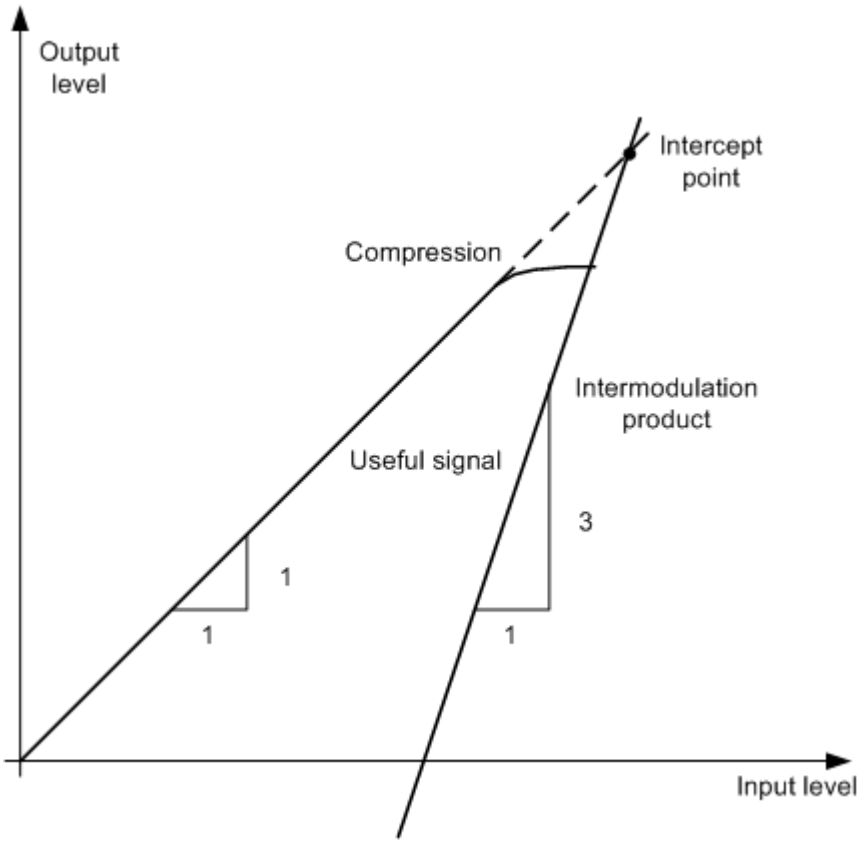


Fig. 2-43: Dependency of intermodulation products on level of useful signals

The useful signals at the two-port output increase proportionally with the input level as long as the two-port is in the linear range. A level change of 1 dB at the input causes a level change of 1 dB at the output. Beyond a certain input level, the two-port goes into compression and the output level stops increasing. The intermodulation products of the third order increase three times as quickly as the useful signals. The intercept point is the fictitious level where the two lines intersect. It cannot be measured directly since the useful level is previously limited by the maximum two-port output power.

Calculation method

However, the intercept point can be calculated from the known line slopes and the measured spacing a_{D3} at a given level according to the following formula:

$$IP3 = \frac{a_{D3}}{2} + P_N$$

The third order intercept point (TOI), for example, is calculated for an intermodulation of 60 dB and an input level P_U of -20 dBm according to the following formula:

$$IP3 = \frac{60}{2} + (-20dBm) = 10dBm$$

Intermodulation-free dynamic range

The "Intermodulation-free dynamic range", i.e. the level range in which no internal intermodulation products are generated if two-tone signals are measured, is determined by the third order intercept point, the phase noise and the thermal noise of the signal analyzer. At high signal levels, the range is determined by intermodulation products. At low signal levels, intermodulation products disappear below the noise floor, i.e. the noise floor and the phase noise of the signal analyzer determine the range. The noise floor and the phase noise depend on the resolution bandwidth that has been selected. At the smallest resolution bandwidth, the noise floor and phase noise are at a minimum and so the maximum range is obtained. However, a large increase in sweep time is required for small resolution bandwidths. It is therefore best to select the largest resolution bandwidth possible to obtain the range that is required. Since phase noise decreases as the carrier-offset increases, its influence decreases with increasing frequency offset from the useful signals.

The following diagrams illustrate the intermodulation-free dynamic range as a function of the selected bandwidth and of the level at the input mixer (= signal level – set RF attenuation) at different useful signal offsets.

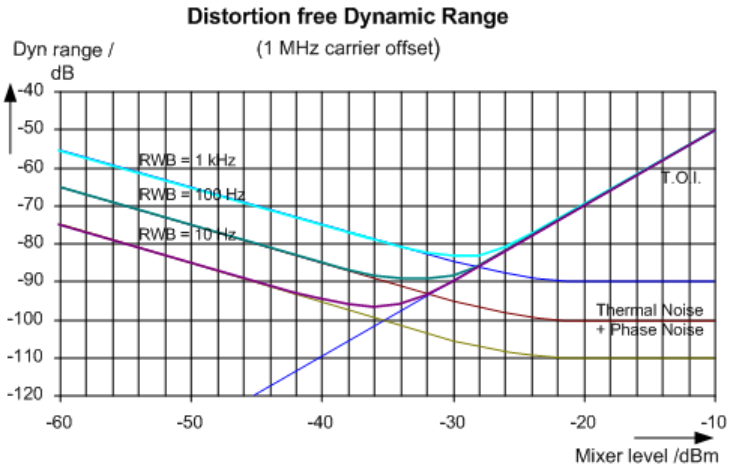


Fig. 2-44: Intermodulation-free range as a function of level at the input mixer and the set resolution bandwidth

(Useful signal offset = 1 MHz, DANL = -145 dBm/Hz, TOI = 15 dBm; typical values at 2 GHz)

The optimum mixer level, i.e. the level at which the intermodulation distance is at its maximum, depends on the bandwidth. At a resolution bandwidth of 10 Hz, it is approx. -35 dBm and at 1 kHz increases to approx. -30 dBm.

Phase noise has a considerable influence on the intermodulation-free range at carrier offsets between 10 and 100 kHz (see figure 2-45). At greater bandwidths, the influence of the phase noise is greater than it would be with small bandwidths. The optimum mixer level at the bandwidths under consideration becomes almost independent of bandwidth and is approx. -40 dBm.

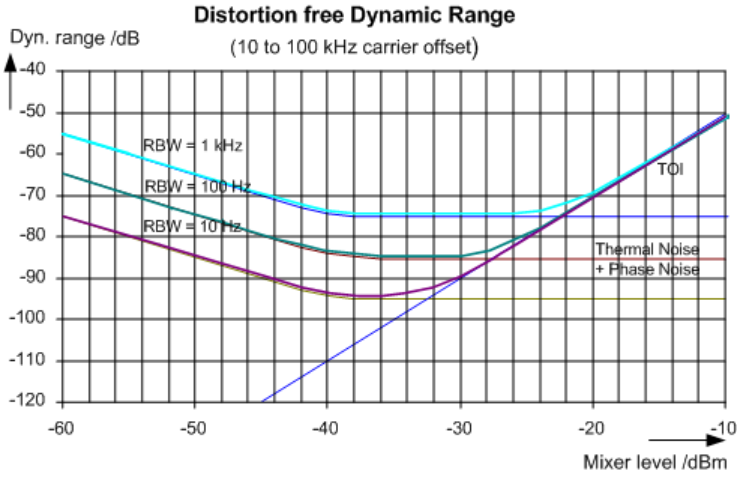


Fig. 2-45: Intermodulation-free dynamic range as a function of level at the input mixer and of the selected resolution bandwidth

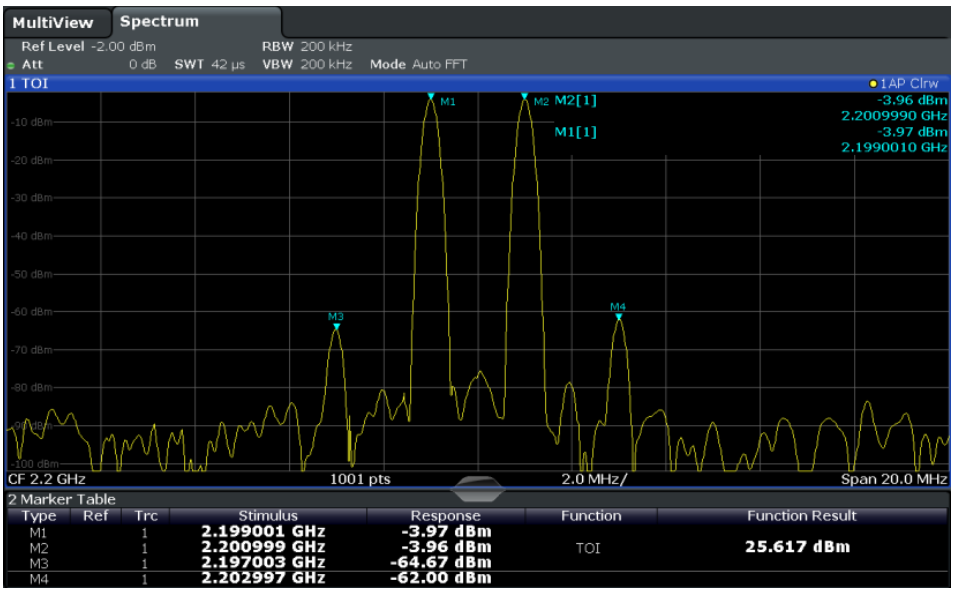
(Useful signal offset = 10 to 100 kHz, DANL = -145 dBm/Hz, TOI = 15 dBm; typical values at 2 GHz).

If the intermodulation products of a DUT with a very high dynamic range are to be measured and the resolution bandwidth to be used is therefore very small, it is best to measure the levels of the useful signals and those of the intermodulation products separately using a small span. The measurement time will be reduced, in particular if the offset of the useful signals is large. To find signals reliably when frequency span is small, it is best to synchronize the signal sources and the R&S FSWP.

2.11.3 TOI Results

As a result of the TOI measurement, the following values are displayed in the marker area of the diagram:

Label	Description
TOI	Third-order intercept point
M1	Maximum of first useful signal
M2	Maximum of second useful signal
M3	First intermodulation product
M4	Second intermodulation product

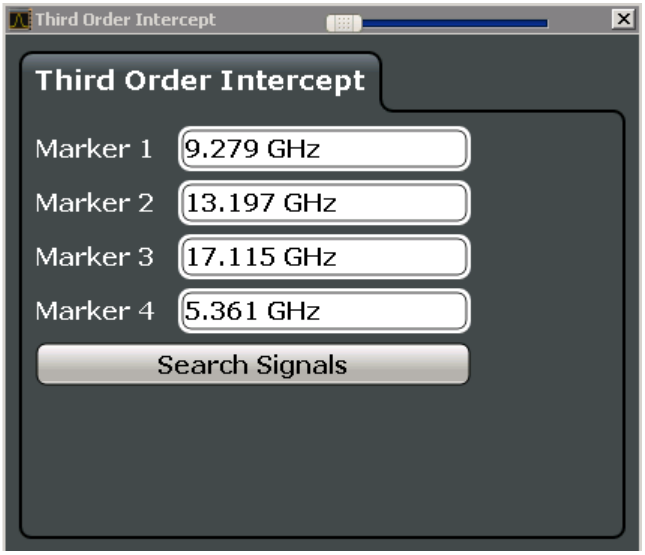


Remote command

The TOI can also be queried using the remote command `CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult?` on page 517.

2.11.4 TOI Configuration

Third Order Intercept (TOI) measurements are selected via the "Third Order Intercept" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Third Order Intercept" dialog box, which is displayed as a tab in the "Analysis" dialog box, or when you select the "TOI Config" softkey from the "TOI" menu.



The remote commands required to perform these tasks are described in chapter 5.2.12, "Measuring the Third Order Intercept Point", on page 517.

Marker 1/2/3/4 186
Search Signals 186

Marker 1/2/3/4
Indicates the detected characteristic values as determined by the TOI measurement (see chapter 2.11.3, "TOI Results", on page 184).

The marker positions can be edited; the TOI is then recalculated according to the new marker values.

To reset all marker positions automatically, use the Search Signals function.

Remote command:
`CALCulate<n>:MARKer<m>:X` on page 627
`CALCulate<n>:DELTamarker<m>:X` on page 625
`CALCulate<n>:DELTamarker<m>:X:RELative?` on page 638

Search Signals
Performs a new search on the input signals and recalculates the TOI according to the measured values.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:TOI:SEARchsignal ONCE` on page 518

2.11.5 How to Determine the Third Order Intercept

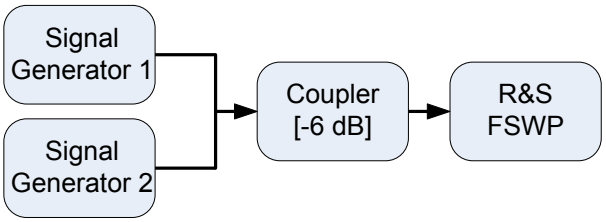
The precise TOI for the R&S FSWP in relation to the input signals is provided in the data sheet.

1. Apply a two-tone signal with equal carrier levels to the R&S FSWP input.
2. On the R&S FSWP, press the MEAS key.
3. Select the "Third Order Intercept" measurement function from the "Select Measurement" dialog box.

   The calculated TOI is indicated in the marker information. The markers required for calculation are displayed in the marker table.
4. If the signal changes significantly during or after the TOI measurement, use the "Search Signals" function to start a new signal search automatically and restart the calculation of the TOI.

2.11.6 Measurement Example – Measuring the R&S FSWP's Intrinsic Intermodulation

Test setup:



Signal generator settings (e.g. R&S FSWP SMW):

Device	Level	Frequency
Signal generator 1	-4 dBm	799.6 MHz
Signal generator 2	-4 dBm	800.4 MHz

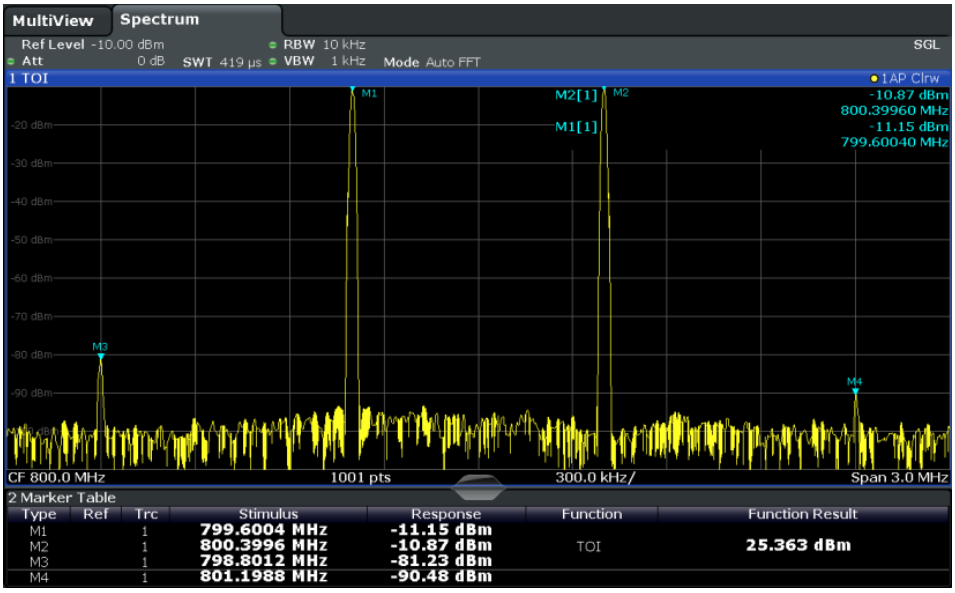
Setting up the measurement

1. Preset the R&S FSWP.
2. Set the center frequency to *800 MHz* and the frequency span to *3 MHz*.
3. Set the reference level to *-10 dBm* and RF attenuation to *0 dB*.
4. Set the resolution bandwidth to *10 kHz*.
   The noise is reduced, the trace is smoothed further and the intermodulation products can be seen clearly.
5. Set the VBW to "1 kHz".

Measuring intermodulation using the Third Order Intercept (TOI) measurement function

1. Press the MEAS key and select the "Third Order Intercept" measurement function from the "Select Measurement" dialog box.

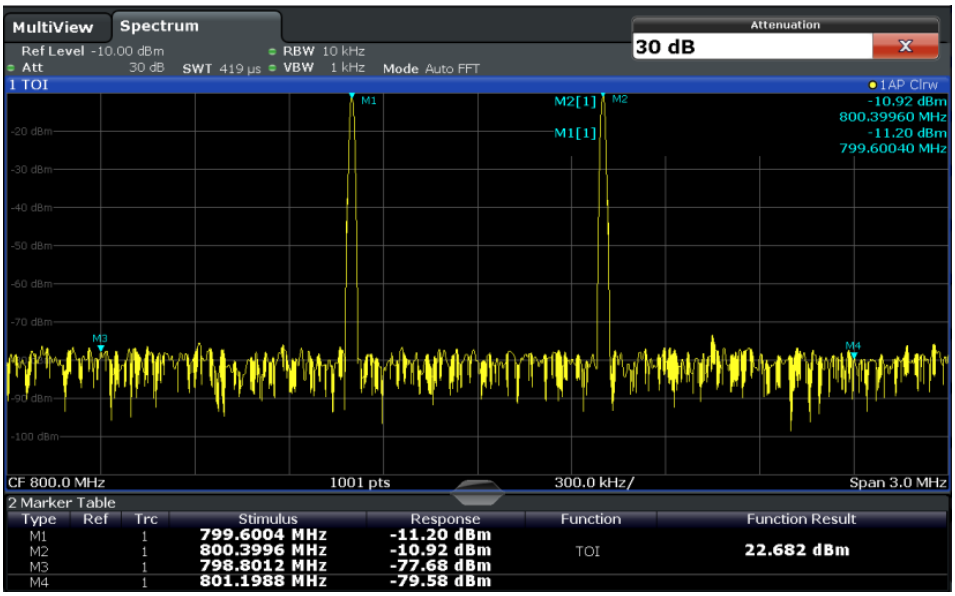
   The R&S FSWP activates four markers to measure the intermodulation distance. Two markers are positioned on the useful signals and two on the intermodulation products. The TOI is calculated from the level difference between the useful signals and the intermodulation products. It is then displayed on the screen:



The third order intercept (TOI) is displayed in the marker information.

2. The level of a signal analyzer's intrinsic intermodulation products depends on the RF level of the useful signals at the input mixer. When the RF attenuation is added, the mixer level is reduced and the intermodulation distance is increased. With an additional RF attenuation of 10 dB, the levels of the intermodulation products are reduced by 20 dB. The noise level is, however, increased by 10 dB.
   Increase the RF attenuation to 20 dB to reduce intermodulation products.

   The R&S FSWP's intrinsic intermodulation products disappear below the noise floor.



2.12 AM Modulation Depth Measurement

Using the R&S FSWP you can measure the AM modulation depth of a modulated signal.

- About the Measurement....189
- AM Modulation Depth Results....189
- AM Modulation Depth Configuration....190
- Optimizing and Troubleshooting the Measurement....191
- How to Determine the AM Modulation Depth....192

2.12.1 About the Measurement

The AM modulation depth, also known as a modulation index, indicates how much the modulated signal varies around the carrier amplitude. It is defined as:

M_{Depth} = peak signal amplitude / unmodulated carrier amplitude

So for M_{Depth} = 0.5, for example, the carrier amplitude varies by 50% above and below its unmodulated level, and for M_{Depth} = 1.0 it varies by 100%.

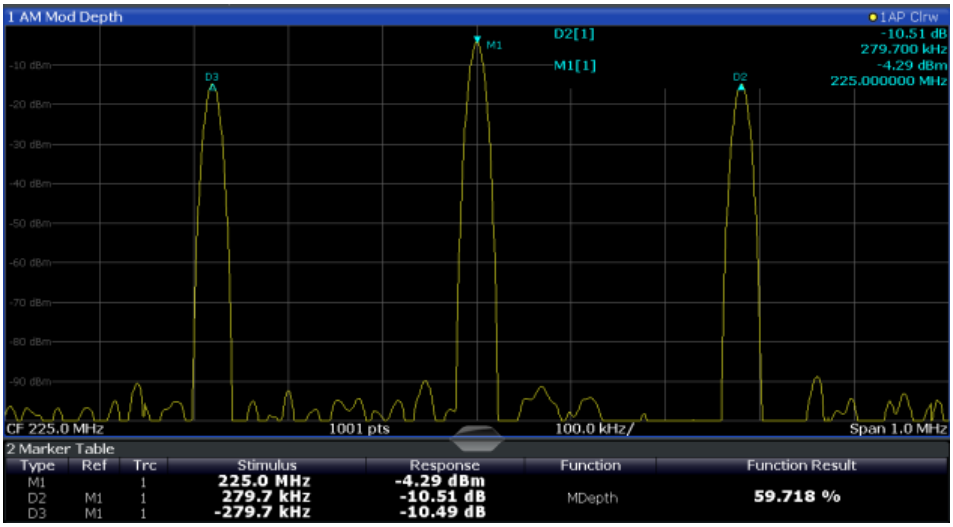
When this measurement is activated, marker 1 is set to the peak level, which is considered to be the carrier level. Delta markers 2 and 3 are automatically set symmetrically to the carrier on the adjacent peak values of the trace. The markers can be adjusted manually, if necessary.

The R&S FSWP calculates the power at the marker positions from the measured levels. The AM modulation depth is calculated as the ratio between the power values at the reference marker and at the delta markers. If the powers of the two AM side bands are unequal, the mean value of the two power values is used for AM modulation depth calculation.

2.12.2 AM Modulation Depth Results

As a result of the AM Modulation Depth measurement, the following values are displayed in the marker area of the diagram:

Label	Description
MDepth	AM modulation depth in percent
M1	Maximum of the signal (= carrier level)
D2	Offset of next peak to the right of the carrier
D3	Offset of the next peak to the left of the carrier

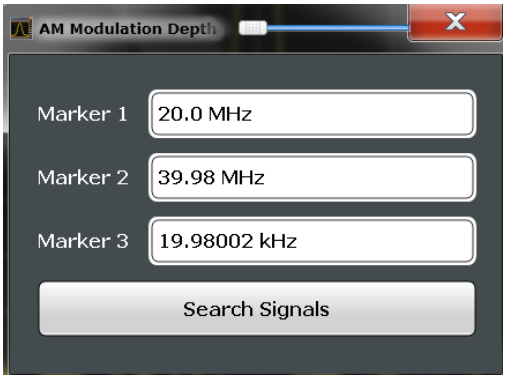


Remote command:

The AM modulation depth can also be queried using the remote command `CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:RESult?` on page 519.

2.12.3 AM Modulation Depth Configuration

AM Modulation Depth measurements are selected via the "AM Modulation Depth" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "AM Modulation Depth" dialog box, which is displayed as a tab in the "Analysis" dialog box or when you select the "AM Mod Depth Config" softkey from the "AM Mod Depth" menu.



The remote commands required to perform these tasks are described in chapter 5.2.13, "Measuring the AM Modulation Depth", on page 519.

Marker 1/2/3 191
Search Signals 191

Marker 1/2/3
Indicates the detected characteristic values as determined by the AM Modulation Depth measurement:

Marker	Description
M1	Maximum of the signal (= carrier level)
D2	Offset of next peak to the right of the carrier
D3	Offset of the next peak to the left of the carrier

The marker positions can be edited; the modulation depth is then recalculated according to the new marker values.

To reset all marker positions automatically, use the Search Signals function.

Note: Moving the marker positions manually. When the position of delta marker 2 is changed, delta marker 3 is moved symmetrically with respect to the reference marker 1.
Delta marker 3, on the other hand, can be moved for fine adjustment independently of marker 2.

Marker 1 can also be moved manually for re-adjustment without affecting the position of the delta markers.

Remote command:
`CALCulate<n>:MARKer<m>:X` on page 627
`CALCulate<n>:DELTamarker<m>:X` on page 625
`CALCulate<n>:DELTamarker<m>:X:RELative?` on page 638

Search Signals
Performs a new search on the input signal and recalculates the AM Modulation Depth according to the measured values.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:SEARchsignal ONCE`
on page 519

2.12.4 Optimizing and Troubleshooting the Measurement

If the results do not meet your expectations, try the following methods to optimize the measurement:

- Set the center frequency to the frequency of the device under test.
- Adjust the span so the peaks to the left and right of the carrier, produced by the AM modulated signal, are clearly visible.
  If the span is too wide, these signals may fall together with the carrier and the measurement can not be performed.
  If the span is too narrow, theses signals are outside of the measured span and the delta markers can not find these peaks.
  The rule of thumb is to set the span to three times the value of the AM modulation frequency.

2.12.5 How to Determine the AM Modulation Depth

1. Apply a modulated carrier signal to the R&S FSWP input.
2. On the R&S FSWP, press the MEAS key.
3. Select the "AM Modulation Depth" measurement function from the "Select Measurement" dialog box.

   The calculated AM Modulation Depth is indicated in the marker information. The markers required for calculation are displayed in the marker table.
4. If the signal changes significantly during or after the AM Modulation Depth measurement, use the "Search Signals" function to start a new peak search automatically and restart the calculation of the AM Modulation Depth.

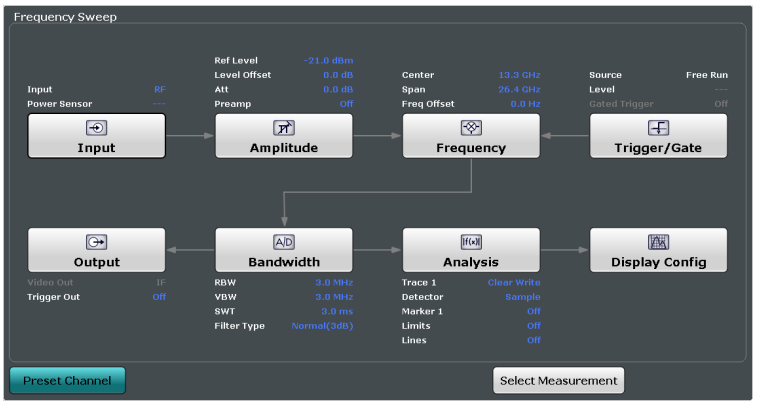
3 Common Measurement Settings

Basic measurement settings that are common to many measurement tasks, regardless of the application or operating mode, are described here. If you are performing a specific measurement task, using an operating mode other than Signal and Spectrum Analyzer mode, or an application other than the Spectrum application, be sure to check the specific application or mode description for settings that may deviate from these common settings.

- Configuration Overview....193
- Data Input and Output....194
- Frequency and Span Configuration....238
- Amplitude and Vertical Axis Configuration....246
- Bandwidth, Filter and Sweep Configuration....255
- Trigger and Gate Configuration....271
- Adjusting Settings Automatically....288
- Transducer....291

3.1 Configuration Overview

Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the configuration "Overview". The "Overview" is displayed when you select the "Overview" icon, which is available at the bottom of all softkey menus.



In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. Thus, you can easily configure an entire measurement channel from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

In particular, the "Overview" provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. "Select Measurement"
   See chapter 2.1, "Available Measurement Functions", on page 12

2. Input
   chapter 3.2.2, "Input Source Settings", on page 197
3. Amplitude
   chapter 3.4, "Amplitude and Vertical Axis Configuration", on page 246
4. Frequency
   See chapter 3.3, "Frequency and Span Configuration", on page 238
5. (Optionally:) Trigger/Gate
   See chapter 3.6, "Trigger and Gate Configuration", on page 271
6. Bandwidth
   See chapter 3.5.2, "Bandwidth, Filter and Sweep Settings", on page 261
   (For SEM measurements: SEM Setup, see chapter 2.6.5, "SEM Configuration", on page 111)
   (For Spurious measurements: Spurious Setup, see chapter 2.7.4, "Spurious Emissions Measurement Configuration", on page 145)
7. (Optionally:) Outputs
   See chapter 3.2.5, "Output Settings", on page 234
8. Analysis
   See chapter 4, "Common Analysis and Display Functions", on page 301
9. Display
   See chapter 4.1, "Result Display Configuration", on page 301

To configure settings

► Select any button to open the corresponding dialog box.
Select a setting in the channel bar (at the top of the measurement channel tab) to change a specific setting.

Preset Channel
Select the "Preset Channel" button in the lower lefthand corner of the "Overview" to restore all measurement settings **in the current channel** to their default values.

Note that the PRESET key restores the entire instrument to its default values and thus closes **all measurement channels** on the R&S FSWP (except for the default channel)!

Remote command:
`SYSTem:PRESet:CHANnel[:EXECute]` on page 543

3.2 Data Input and Output

The R&S FSWP can analyze signals from different input sources and provide various types of output (such as video or trigger signals).

- Receiving Data Input and Providing Data Output 195
- Input Source Settings 197
- Power Sensors 198
- Optional External Generator Control 207
- Output Settings 234

3.2.1 Receiving Data Input and Providing Data Output

The R&S FSWP can analyze signals from different input sources and provide various types of output (such as noise or trigger signals).

- RF Input Protection 195
- Input from Noise Sources 195
- Receiving and Providing Trigger Signals 196
- IF and Video Signal Output 196

3.2.1.1 RF Input Protection

The RF input connector of the R&S FSWP must be protected against signal levels that exceed the ranges specified in the data sheet. Therefore, the R&S FSWP is equipped with an overload protection mechanism. This mechanism becomes active as soon as the power at the input mixer exceeds the specified limit. It ensures that the connection between RF input and input mixer is cut off.

When the overload protection is activated, an error message is displayed in the status bar ("INPUT OVLD"), and a message box informs you that the RF Input was disconnected. Furthermore, a status bit (bit 3) in the `STAT:QUES:POW` status register is set. In this case you must decrease the level at the RF input connector and then close the message box. Then measurement is possible again. Reactivating the RF input is also possible via the remote command `INPut:ATTenuation:PROTection:RESet`.

3.2.1.2 Input from Noise Sources

The R&S FSWP provides a connector (NOISE SOURCE CONTROL) with a voltage supply for an external noise source. By switching the supply voltage for an external noise source on or off in the firmware, you can activate or deactive the device as required.

External noise sources are useful when you are measuring power levels that fall below the noise floor of the R&S FSWP itself, for example when measuring the noise level of an amplifier.

In this case, you can first connect an external noise source (whose noise power level is known in advance) to the R&S FSWP and measure the total noise power. From this value you can determine the noise power of the R&S FSWP. Then when you measure the power level of the actual DUT, you can deduct the known noise level from the total power to obtain the power level of the DUT.

The noise source is controlled in the "Output" settings, see "Noise Source" on page 236

3.2.1.3 Receiving and Providing Trigger Signals

Using one of the TRIGGER connectors of the R&S FSWP, the R&S FSWP can use a signal from an external reference as a trigger to capture data. Alternatively, the internal trigger signal used by the R&S FSWP can be output for use by other connected devices. Using the same trigger on several devices is useful to synchronize the transmitted and received signals within a measurement.

For details on the connectors see the R&S FSWP "Getting Started" manual.

External trigger as input

If the trigger signal for the R&S FSWP is provided by an external reference, the reference signal source must be connected to the R&S FSWP and the trigger source must be defined as "External" for the R&S FSWP.

Trigger output

The R&S FSWP can provide output to another device either to pass on the internal trigger signal, or to indicate that the R&S FSWP itself is ready to trigger.

The trigger signal can be output by the R&S FSWP automatically, or manually by the user. If it is provided automatically, a high signal is output when the R&S FSWP has triggered due to a measurement start ("Device Triggered"), or when the R&S FSWP is ready to receive a trigger signal after a measurement start ("Trigger Armed").

Manual triggering

If the trigger output signal is initiated manually, the length and level (high/low) of the trigger pulse is also user-definable. Note, however, that the trigger pulse level is always opposite to the constant signal level defined by the output "Level" setting, e.g. for "Level = High", a constant high signal is output to the connector until the "Send Trigger" button is selected. Then, a low pulse is provided.

3.2.1.4 IF and Video Signal Output

The measured IF signal or displayed video signal (i.e. the filtered and detected IF signal) can be provided at the IF/VIDEO/DEMOD output connector of the R&S FSWP.

The **video output** is a signal of 1 V. It can be used, for example, to control demodulated audio frequencies.

The **IF output** is a signal of the measured level at a specified frequency.

Restrictions

Note the following restrictions for IF output:

- IF and video output is only available in the time domain (zero span).
- For I/Q data, only IF output is available.

3.2.2 Input Source Settings

The input source determines which data the R&S FSWP will analyze.

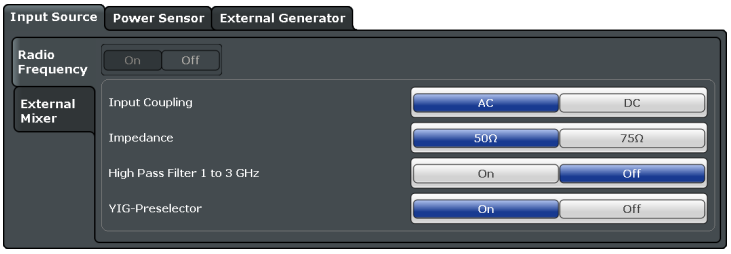
Input settings can be configured in the "Input" dialog box.

Some settings are also available in the "Amplitude" tab of the "Amplitude" dialog box.

- Radio Frequency Input 197

3.2.2.1 Radio Frequency Input

The default input source for the R&S FSWP is "Radio Frequency", i.e. the signal at the RF INPUT connector of the R&S FSWP. If no additional options are installed, this is the only available input source.



Radio Frequency State 197
Input Coupling 197
Impedance 197
High-Pass Filter 1...3 GHz 198
YIG-Preselector 198

Radio Frequency State
Activates input from the RF INPUT connector.

Remote command:
`INPut:SELect` on page 544

Input Coupling
The RF input of the R&S FSWP can be coupled by alternating current (AC) or direct current (DC).

AC coupling blocks any DC voltage from the input signal. This is the default setting to prevent damage to the instrument. Very low frequencies in the input signal may be distorted.

However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the data sheet.

Remote command:
`INPut:COUPling` on page 545

Impedance
For some measurements, the reference impedance for the measured levels of the R&S FSWP can be set to 50 Ω or 75 Ω.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

This value also affects the unit conversion.

Remote command:
`INPut:IMPedance` on page 546

High-Pass Filter 1...3 GHz
Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the analyzer in order to measure the harmonics for a DUT, for example.

This function requires an additional hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG filter.)

Remote command:
`INPut:FILTer:HPASs[:STATe]` on page 546

YIG-Preselector
Activates or deactivates the YIG-preselector, if available on the R&S FSWP.

An internal YIG-preselector at the input of the R&S FSWP ensures that image frequencies are rejected. However, this is only possible for a restricted bandwidth. In order to use the maximum bandwidth for signal analysis you can deactivate the YIG-preselector at the input of the R&S FSWP, which may lead to image-frequency display.

Note that the YIG-preselector is active only on frequencies greater than 8 GHz. Therefore, switching the YIG-preselector on or off has no effect if the frequency is below that value.

Note:
For the following measurements, the YIG-Preselector is off by default (if available).
- VSA

Remote command:
`INPut:FILTer:YIG[:STATe]` on page 546

3.2.3 Power Sensors

The R&S FSWP can also analyze data from a connected power sensor.

- Basics on Power Sensors 198
- Power Sensor Settings 200
- How to Work With a Power Sensor 205

3.2.3.1 Basics on Power Sensors

For precise power measurement up to 4 power sensors can be connected to the instrument via the power sensor interface (on the front panel). Both manual operation and remote control are supported.

Currently, only R&S NRP-Zxy power sensors are supported. For a detailed list of supported sensors see the data sheet.

Power sensors can also be used to trigger a measurement at a specified power level, e.g. from a signal generator (see "Using a Power Sensor as an External Power Trigger" on page 199).

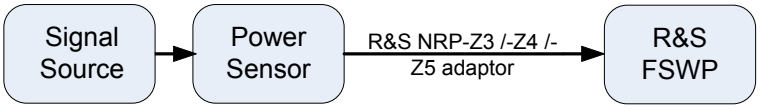


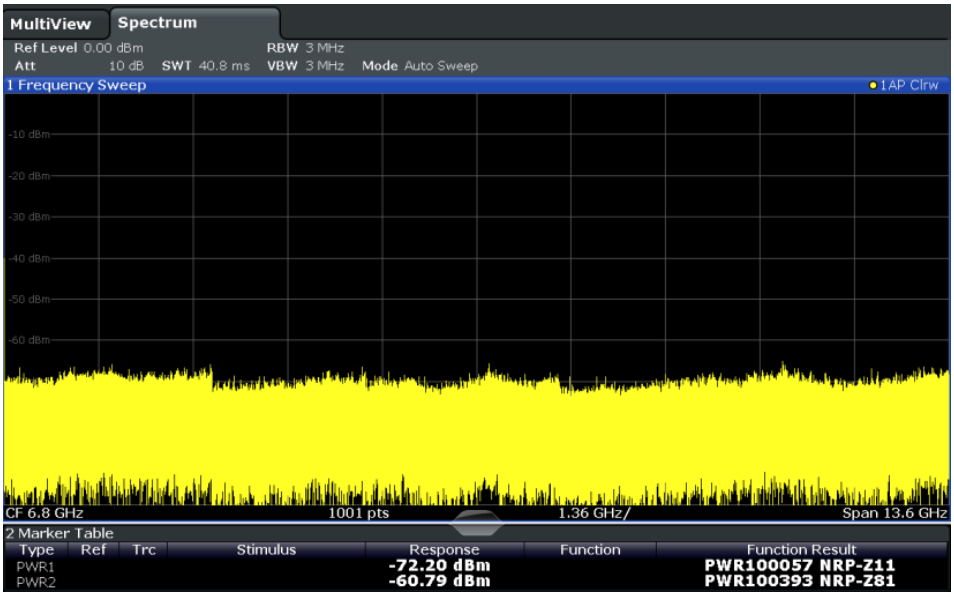
Fig. 3-1: Power sensor support – standard test setup

Using the power sensor with several applications

The power sensor cannot be used from the R&S FSWP firmware and the R&S Power Viewer Plus (virtual power meter for displaying results of the R&S NRP power sensors) simultaneously.

Result display

The results of the power sensor measurements are displayed in the marker table. For each power sensor, a row is inserted. The sensor index is indicated in the "Type" column.



Using a Power Sensor as an External Power Trigger

Power sensors can be used to trigger a measurement at a specified power level, e.g. from a signal generator.

Currently, only the following power sensors are supported as power triggers:

- R&S NRP-Z81
- R&S NRP-Z85
- R&S NRP-Z86
- R&S NRP8S, R&S NRP18S, R&S NRP33S
- R&S NRP8SN, R&S NRP18SN, R&S NRP33SN

With the R&S FSWP, the power sensors can be connected to the "Power Sensor" interface directly, and no further cables are required. They can then be configured as an external power sensor trigger.

Fig. 3-2: Connecting a power sensor using the POWER SENSOR interface

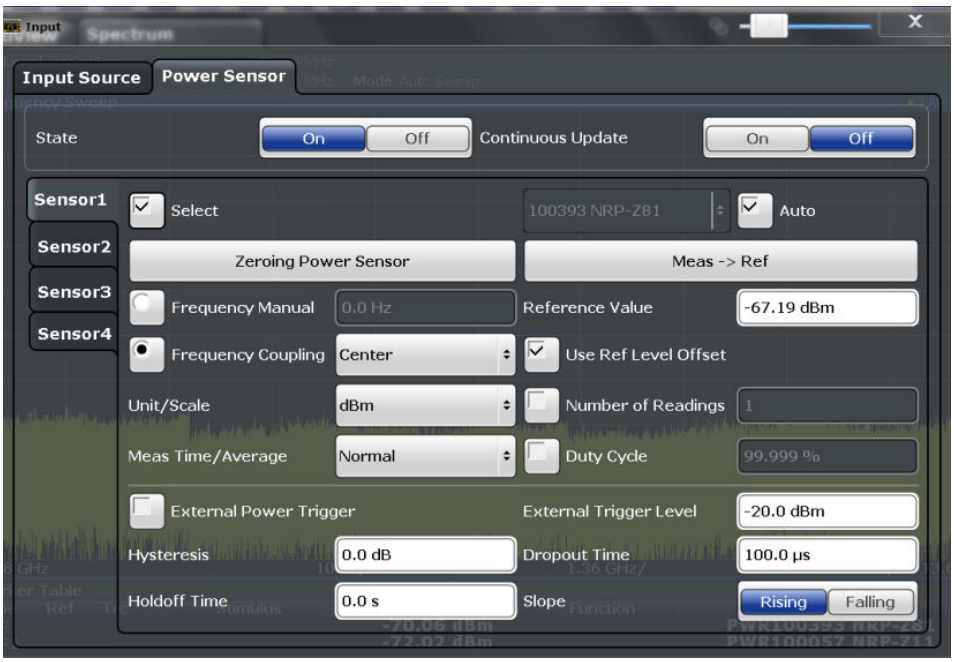
The R&S FSWP receives an external trigger signal when the defined trigger level is measured by the power sensor. Power measurement results are provided as usual.

The "Gate Mode" *Level* is not supported for R&S power sensors. The signal sent by these sensors merely reflects the instant the level is first exceeded, rather than a time period. However, only time periods can be used for gating in level mode. Thus, the trigger impulse from the sensors is not long enough for a fully gated measurement; the measurement cannot be completed. For details on gating see chapter 3.6.1.2, "Gated Measurements", on page 275.

For details see "How to Configure a Power Sensor as an External (PSE) Trigger" on page 207.

3.2.3.2 Power Sensor Settings

Power sensor settings are available in the "Power Sensor" tab of the "Input" dialog box. Each sensor is configured on a separate tab.



State....201
Continuous Value Update....202
Select....202
Zeroing Power Sensor....202
Frequency Manual....202
Frequency Coupling....203
Unit/Scale....203
Meas Time/Average....203
Setting the Reference Level from the Measurement (Meas->Ref)....203
Reference Value....203
Use Ref Lev Offset....204
Average Count (Number of Readings)....204
Duty Cycle....204
Using the power sensor as an external trigger....204
└ External Trigger Level....204
└ Hysteresis....205
└ Trigger Holdoff....205
└ Drop-Out Time....205
└ Slope....205

State

Switches the power measurement for all power sensors on or off. Note that in addition to this general setting, each power sensor can be activated or deactivated individually by the Select setting on each tab. However, the general setting overrides the individual settings.

Remote command:

`[SENSe:]PMETer<p>[:STATe]` on page 550

Continuous Value Update
If activated, the power sensor data is updated continuously during a sweep with a long sweep time, and even after a single sweep has completed.

This function cannot be activated for individual sensors.

If the power sensor is being used as a trigger (see "Using the power sensor as an external trigger" on page 204), continuous update is not possible; this setting is ignored.

Remote command:
`[SENSe:]PMETer<p>:UPDate[:STATe]` on page 555

Select
Selects the individual power sensor for usage if power measurement is generally activated (State function).

The detected **serial numbers** of the power sensors connected to the instrument are provided in a selection list. For each of the four available power sensor indexes ("Power Sensor 1"..."Power Sensor 4"), which correspond to the tabs in the configuration dialog, one of the detected serial numbers can be assigned. The physical sensor is thus assigned to the configuration setting for the selected power sensor index.

By default, serial numbers not yet assigned are automatically assigned to the next free power sensor index for which "Auto Assignment" is selected.

Alternatively, you can assign the sensors manually by deactivating the "Auto" option and selecting a serial number from the list.

Remote command:
`[SENSe:]PMETer<p>[:STATe]` on page 550
`SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine` on page 556
`SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe]` on page 556
`SYSTem:COMMunicate:RDEVice:PMETer:COUNt?` on page 556

Zeroing Power Sensor
Starts zeroing of the power sensor.

For details on the zeroing process refer to "How to Zero the Power Sensor" on page 206.

Remote command:
`CALibration:PMETer<p>:ZERO:AUTO ONCE` on page 548

Frequency Manual
Defines the frequency of the signal to be measured. The power sensor has a memory with frequency-dependent correction factors. This allows extreme accuracy for signals of a known frequency.

Remote command:
`[SENSe:]PMETer<p>:FREQuency` on page 551

Frequency Coupling
Selects the coupling option. The frequency can be coupled automatically to the center frequency of the instrument or to the frequency of marker 1.

Remote command:
[SENSe:]PMETer<p>:FREQuency:LINK on page 551

Unit/Scale
Selects the unit with which the measured power is to be displayed. Available units are dBm, dB, W and %.

If dB or % is selected, the display is relative to the reference value that is defined with either the "Meas -> Ref" setting or the "Reference Value" setting.

Remote command:
UNIT<n>:PMETer<p>:POWer on page 557
UNIT<n>:PMETer<p>:POWer:RATio on page 557

Meas Time/Average
Selects the measurement time or switches to manual averaging mode. In general, results are more precise with longer measurement times. The following settings are recommended for different signal types to obtain stable and precise results:

"Short"	Stationary signals with high power (> -40dBm), because they require only a short measurement time and short measurement time provides the highest repetition rates.
"Normal"	Signals with lower power or modulated signals
"Long"	Signals at the lower end of the measurement range (<-50 dBm) or Signals with lower power to minimize the influence of noise
"Manual"	Manual averaging mode. The average count is set with the Average Count (Number of Readings) setting.

Remote command:
[SENSe:]PMETer<p>:MTIMe on page 552
[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe] on page 552

Setting the Reference Level from the Measurement (Meas->Ref)
Sets the currently measured power as a reference value for the relative display. The reference value can also be set manually via the Reference Value setting.

Remote command:
CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE on page 549

Reference Value
Defines the reference value for relative measurements in the unit dBm.

Remote command:
CALCulate<n>:PMETer<p>:RELative[:MAGNitude] on page 549

Use Ref Lev Offset
If activated, takes the reference level offset defined for the analyzer into account for the measured power (see "Shifting the Display (Offset)" on page 250). If deactivated, takes no offset into account.

Remote command:
`[SENSe:]PMETer<p>:ROFFset[:STATe]` on page 553

Average Count (Number of Readings)
Defines the number of readings (averages) to be performed after a single sweep has been started. This setting is only available if manual averaging is selected (Meas Time/ Average setting).

The values for the average count range from 0 to 256 in binary steps (1, 2, 4, 8, …). For average count = 0 or 1, one reading is performed. The general averaging and sweep count for the trace are independent from this setting.

Results become more stable with extended average, particularly if signals with low power are measured. This setting can be used to minimize the influence of noise in the power sensor measurement.

Remote command:
`[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt` on page 552

Duty Cycle
Sets the duty cycle to a percent value for the correction of pulse-modulated signals and activates the duty cycle correction. With the correction activated, the sensor calculates the signal pulse power from this value and the mean power.

Remote command:
`[SENSe:]PMETer<p>:DCYCle[:STATe]` on page 550
`[SENSe:]PMETer<p>:DCYCle:VALue` on page 550

Using the power sensor as an external trigger
If activated, the power sensor creates a trigger signal when a power higher than the defined "External Trigger Level" is measured. This trigger signal can be used as an external power trigger by the R&S FSWP.

This setting is only available in conjunction with a compatible power sensor.

For details on using a power sensor as an external trigger, see "Using a Power Sensor as an External Power Trigger" on page 199.

Remote command:
`[SENSe:]PMETer<p>:TRIGger[:STATe]` on page 555
`TRIG:SOUR PSE`, see `TRIGger[:SEQuence]:SOURce` on page 592

External Trigger Level ← Using the power sensor as an external trigger
Defines the trigger level for the power sensor trigger.

For details on supported trigger levels, see the data sheet.

Remote command:
`[SENSe:]PMETer<p>:TRIGger:LEVel` on page 554

Hysteresis ← Using the power sensor as an external trigger
Defines the distance in dB to the trigger level that the trigger source must exceed before a trigger event occurs. Setting a hysteresis avoids unwanted trigger events caused by noise oscillation around the trigger level.

Remote command:
`[SENSe:]PMETer<p>:TRIGger:HYSTeresis` on page 554

Trigger Holdoff ← Using the power sensor as an external trigger
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

Remote command:
`[SENSe:]PMETer<p>:TRIGger:HOLDoff` on page 553

Drop-Out Time ← Using the power sensor as an external trigger
Defines the time the input signal must stay below the trigger level before triggering again.

Slope ← Using the power sensor as an external trigger
Defines whether triggering occurs when the signal rises to the trigger level or falls down to it.

Remote command:
`[SENSe:]PMETer<p>:TRIGger:SLOPe` on page 555

3.2.3.3 How to Work With a Power Sensor

The following step-by-step instructions demonstrate how to set up a power sensor. For details on individual functions and settings see chapter 3.2.3.2, "Power Sensor Settings", on page 200.

The remote commands required to perform these tasks are described in chapter 5.7.1.3, "Configuring Power Sensors", on page 547.

Power sensors can also be used to trigger a measurement at a specified power level, e.g. from a signal generator.

This is described in "How to Configure a Power Sensor as an External (PSE) Trigger" on page 207.

How to Set Up a Power Sensor

Up to 4 external power sensors can be configured separately and used for precise power measurement. All power sensors can be activated and deactivated individually.

The following procedure describes in detail how to configure and activate power sensors.

1. To display the "Power Sensor" tab of the "Input" dialog box, do one of the following:
   - Select "Input" from the "Overview".
   - Select the INPUT/OUTPUT key and then the "Power Sensor Config" softkey.

2. Select the tab for the power sensor index you want to configure, e.g. "Sensor 1".
3. Press "Select" to analyze the power sensor data according to the current configuration when power measurement is activated.
4. From the selection list with serial numbers of connected power sensors, select the sensor you want to configure.
   To have newly connected power sensors assigned to a tab automatically (default), select "Auto".
5. Define the frequency of the signal whose power you want to measure.
   a) To define the frequency manually, select "Frequency Manual" and enter a frequency.
   b) To determine the frequency automatically, select "Frequency Coupling" and then either "Center", to use the center frequency, or "Marker", to use the frequency defined by marker 1.
6. Select the unit for the power result display.
7. Select the measurement time for which the average is calculated, or define the number of readings to average. To define the number of readings to be taken into account manually, select "Manual" and enter the number in the "Number of Readings" field.
8. To activate the duty cycle correction, select "DutyCycle" and enter a percentage as the correction value.
9. If you selected "dB" or "%" as units (relative display), define a reference value:
   a) To set the currently measured power as a reference value, press the "Meas -> Ref" button.
   b) Alternatively, enter a value manually in the "Reference Value" field.
   c) Optionally, select the "Use Ref Level Offset" option to take the reference level offset set for the analyzer into account for the measured power.
10. To use the power sensor as an external power trigger, select the "External Power Trigger" option and define the trigger settings.
    For details see "How to Configure a Power Sensor as an External (PSE) Trigger" on page 207.
11. If necessary, repeat steps 3-10 for another power sensor.
12. Set the "Power Sensor State" at the top of the "Power Sensor" tab to "On" to activate power measurement for the selected power sensors.

    The results of the power measurement are displayed in the marker table (Function: "Sensor<1...4>").

How to Zero the Power Sensor

1. To display the "Power Sensor" tab of the "Input" dialog box, do one of the following:
   - Select "Input" from the "Overview".

- Select the INPUT/OUTPUT key and then the "Power Sensor Config" softkey.

2. Select the tab that is assigned to the power sensor you want to zero.
3. Press the "Zeroing Power Sensor" button.
   A dialog box is displayed that prompts you to disconnect all signals from the input of the power sensor.
4. Disconnect all signals sending input to the power sensor and press ENTER to continue.
5. Wait until zeroing is complete.
   A corresponding message is displayed.

How to Configure a Power Sensor as an External (PSE) Trigger

The following step-by-step instructions demonstrate how to configure a power sensor to be used as an external power sensor trigger.

To configure a power sensor as an external power sensor (PSE) trigger

1. Connect a compatible power sensor to the "Power Sensor" interface on the front panel of the R&S FSWP. (For details on supported sensors see "Using a Power Sensor as an External Power Trigger" on page 199).
2. Set up the power sensor as described in "How to Set Up a Power Sensor" on page 205.
3. In the "Power Sensor" tab of the "Input" dialog box, select the "External Power Trigger" option.
4. Enter the power level at which a trigger signal is to be generated ("External Trigger Level") and the other trigger settings for the power sensor trigger.
5. Press the TRIG key and then select "Trigger /Gate Config".
6. In the "Trigger and Gate" dialog box, select "Signal Source" = "PSE".

   The R&S FSWP is configured to trigger when the defined conditions for the power sensor occur. Power measurement results are provided as usual.

3.2.4 Optional External Generator Control

If the R&S FSWP optional External Generator Control is installed, you can operate various commercially available generators as an external generator with the R&S FSWP. Thus, scalar network analysis with the R&S FSWP is possible.

- About External Generator Control....208
- Basics on External Generator Control....208
- External Generator Control Settings....220
- How to Work With External Generator Control....227
- Measurement Example: Calibration with an External Generator....229

3.2.4.1 About External Generator Control

A common measurement setup includes a signal generator, a device under test (DUT), and a signal and spectrum analyzer, for example the R&S FSWP. In this setup, the signal analyzer can control which signal the generator is to send, which is in turn measured by the analyzer. This process is referred to as *external generator control*. The generator in this setup is referred to as a *tracking generator*.

A measurement with a tracking generator is useful to measure any effects on the power level caused by the cables and connectors from the signal generator and the signal analyzer in advance. The known effects can then be removed from the measurement results in order to obtain accurate information on the DUT.

3.2.4.2 Basics on External Generator Control

Some background knowledge on basic terms and principles used for external generator control is provided here for a better understanding of the required configuration settings.

External generator control is only available in the Spectrum, I/Q Analyzer, Analog Demodulation and Noise Figure applications.

- External Generator Connections....208
- Overview of Supported Generators....211
- Generator Setup Files....213
- Calibration Mechanism....213
- Normalization....214
- Reference Trace, Reference Line and Reference Level....215
- Coupling the Frequencies....216
- Displayed Information and Errors....219

External Generator Connections

The external generator is controlled either via a LAN connection or via the EXT. GEN. CONTROL GPIB interface of the R&S FSWP supplied with the option.

For more information on configuring interfaces see the R&S FSWP User Manual.

TTL synchronization

In addition, TTL synchronization can be used with some Rohde & Schwarz generators connected via GPIB. The TTL interface is included in the AUX CONTROL connector of the External Generator Control option.

Using the TTL interface allows for considerably higher measurement rates than pure GPIB control, because the frequency stepping of the R&S FSWP is directly coupled with the frequency stepping of the generator. For details see "Coupling the Frequencies" on page 216.

In figure 3-3 the TTL connection is illustrated using an R&S SMU generator, for example.

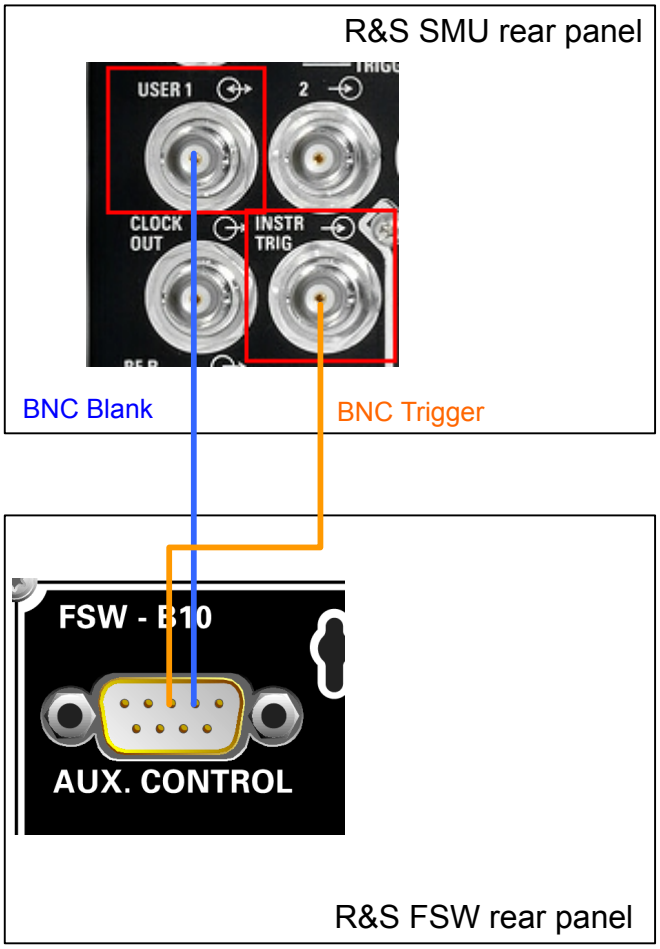


Fig. 3-3: TTL connection for an R&S SMU generator

In figure 3-4, the connection for an R&S SMW is shown.

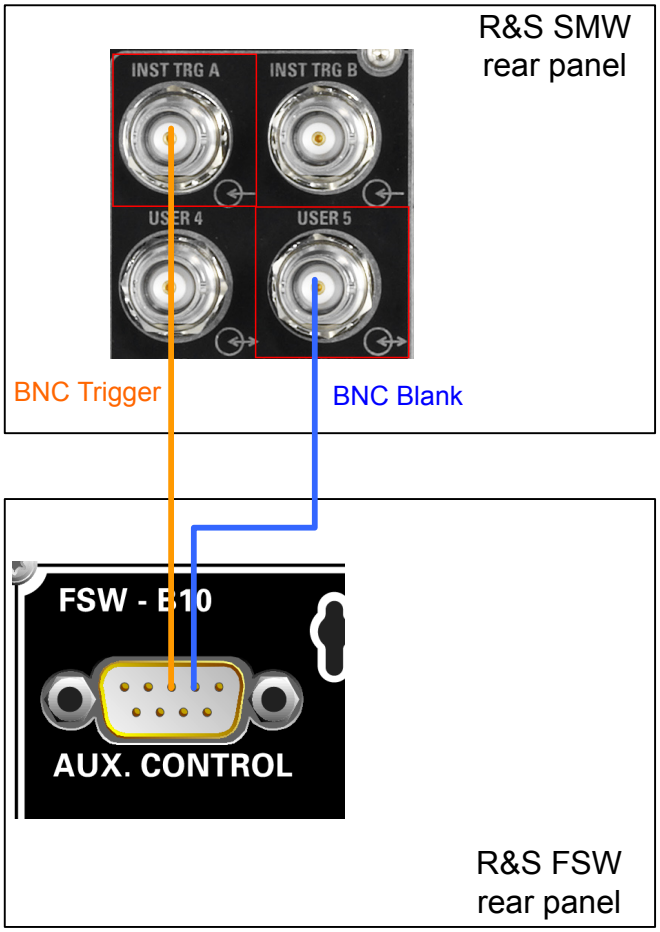


Fig. 3-4: TTL connection for an R&S SMW generator

The external generator can be used to calibrate the data source by performing either transmission or reflection measurements.

Transmission Measurement

This measurement yields the transmission characteristics of a two-port network. The external generator is used as a signal source. It is connected to the input connector of the DUT. The input of the R&S FSWP is fed from the output of the DUT. A calibration can be carried out to compensate for the effects of the test setup (e.g. frequency response of connecting cables).

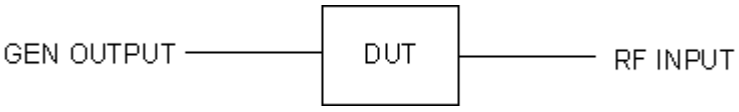


Fig. 3-5: Test setup for transmission measurement

Reflection Measurement

Scalar reflection measurements can be carried out using a reflection-coefficient measurement bridge.

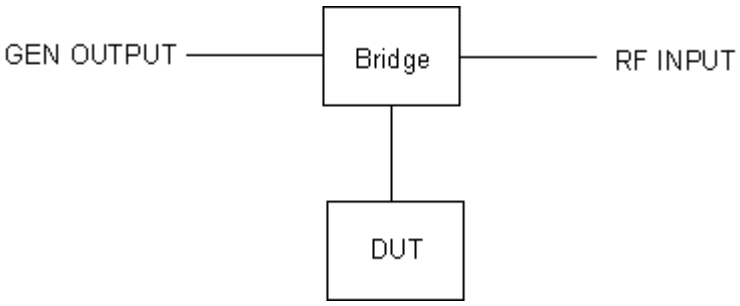


Fig. 3-6: Test setup for reflection measurement

Generated signal input

In order to use the functions of the external generator, an appropriate generator must be connected and configured correctly. In particular, the generator output must be connected to the RF input of the R&S FSWP.

External reference frequency

In order to enhance measurement accuracy, a common reference frequency should be used for both the R&S FSWP and the generator. If no independent 10 MHz reference frequency is available, it is recommended that you connect the reference output of the generator with the reference input of the R&S FSWP and that you enable usage of the external reference on the R&S FSWP via "SETUP" > "Reference" > "External Reference".

For more information on external references see the R&S FSWP User Manual.

Connection errors

If no external generator is connected, if the connection address is not correct, or the generator is not ready for operation, an error message is displayed (e.g."Ext. Generator TCPIP Handshake Error!", see "Displayed Information and Errors" on page 219).

Overview of Supported Generators

Generator type	TTL support	Generator type	TTL support
SGS100A6	-	SMP03	X
SGS100A12	-	SMP04	X
SMA01A [1)]	X	SMP22	X
SMA100A3	X	SMR20	-
SMA100A6	X	SMR20B11 [3)]	X
SMB100A1	X	SMR27	X

1) Requires firmware version V2.10.x or higher on the signal generator
2) Requires firmware version V1.10.x or higher on the signal generator
3) Requires the option SMR-B11 on the signal generator
4) Requires firmware version V3.20.200 or higher on the signal generator

Generator type	TTL support	Generator type	TTL support
SMB100A12	X	SMR27B11 3)	X
SMB100A2	X	SMR30	X
SMB100A20	X	SMR30B11 3)	X
SMB100A3	X	SMR40	X
SMB100A40	X	SMR40B11 3)	X
SMBV100A3	X	SMR50	X
SMBV100A6	X	SMR50B11 3)	X
SMC100A1	-	SMR60	X
SMC100A3	-	SMR60B11 3)	X
SME02	X	SMT02	-
SME03	X	SMT03	-
SME06	X	SMT06	-
SMF100A	X	SMU02	X
SMF22	X	SMU02B31 2)	X
SMF22B2	X	SMU03 2)	X
SMF43	X	SMU03B31 2)	X
SMF43B2	X	SMU04 2)	X
SMG	-	SMU04B31 2)	X
SMGL	-	SMU06 2)	X
SMGU	-	SMU06B31 2)	X
SMH	-	SMV03	-
SMHU	-	SMW03	X4)
SMIQ02	X	SMW06	X4)
SMIQ02B	X	SMW20	X4)
SMIQ02E	-	SMW40	X4)
SMIQ03	X	SMX	-
SMIQ03B	X	SMY01	-
SMIQ03E	-	SMY02	-
SMIQ04B	X	HP8254A	-
SMIQ06B	X	HP8257D	-

1) Requires firmware version V2.10.x or higher on the signal generator
2) Requires firmware version V1.10.x or higher on the signal generator
3) Requires the option SMR-B11 on the signal generator
4) Requires firmware version V3.20.200 or higher on the signal generator

Generator type	TTL support	Generator type	TTL support
SMJ03	X	HP8340A	-
SMJ06	X	HP8648	-
SML01	-	HP ESG-A Series 1000A, 2000A, 3000A, 4000A	-
SML02	-	HP ESG B Series	-
SML03	-		
SMP02	X		
1) Requires firmware version V2.10.x or higher on the signal generator 2) Requires firmware version V1.10.x or higher on the signal generator 3) Requires the option SMR-B11 on the signal generator 4) Requires firmware version V3.20.200 or higher on the signal generator			

Generator Setup Files

For each signal generator type to be controlled by the R&S FSWP a generator setup file must be configured and stored on the R&S FSWP. The setup file defines the frequency and power ranges supported by the generator, as well as information required for communication. For the signal generators listed in "Overview of Supported Generators" on page 211, default setup files are provided. If necessary, these files can be edited or duplicated for varying measurement setups or other instruments.

The existing setup files can be displayed in an editor in read-only mode directly from the "External Generator" configuration dialog box. From there, they can be edited and stored under a different name, and are then available on the R&S FSWP.

(For details see "To define a new generator setup file" on page 228).

Calibration Mechanism

A common measurement setup includes a signal generator, a device under test (DUT), and a signal and spectrum analyzer. Therefore, it is useful to measure the attenuation or gain caused by the cables and connectors from the signal generator and the signal analyzer in advance. The known level offsets can then be removed from the measurement results in order to obtain accurate information on the DUT.

Calculating the difference between the currently measured power and a reference trace is referred to as *calibration*. Thus, the measurement results from the controlled external generator - including the inherent distortions - can be used as a reference trace to calibrate the measurement setup.

The inherent frequency and power level distortions can be determined by connecting the R&S FSWP to the signal generator. The R&S FSWP sends a predefined list of frequencies to the signal generator (see also "Coupling the Frequencies" on page 216). The signal generator then sends a signal with the specified level at each frequency in the predefined list. The R&S FSWP measures the signal and determines the level offsets to the expected values.

Saving calibration results

A reference dataset for the calibration results is stored internally as a table of value pairs (frequency/level), one for each sweep point. The measured offsets can then be used as calibration factors for subsequent measurement results.

The calibration can be performed using either transmission or reflection measurements. The selected type of measurement used to determine the reference trace is included in the reference dataset.

Normalization

Once the measurement setup has been calibrated and the reference trace is available, subsequent measurement results can be corrected according to the calibration factors, if necessary. This is done by subtracting the reference trace from the measurement results. This process is referred to as *normalization* and can be activated or deactivated as required. If normalization is activated, "NOR" is displayed in the channel bar, next to the indication that an external generator is being used ("Ext.Gen").The normalized trace from the calibration sweep is a constant 0 dB line, as <calibration trace> - <reference trace> = 0.

As long as the same settings are used for measurement as for calibration, the normalized measurement results should not contain any inherent frequency or power distortions. Thus, the measured DUT values are very accurate.

Approximate normalization

As soon as any of the calibration measurement settings are changed, the stored reference trace will no longer be identical to the new measurement results. However, if the measurement settings do not deviate too much, the measurement results can still be normalized *approximately* using the stored reference trace. This is indicated by the "APX" label in the channel bar (instead of "NOR").

This is the case if one or more of the following values deviate from the calibration settings:

- coupling (RBW, VBW, SWT)
- reference level, RF attenuation
- start or stop frequency
- output level of external generator
- detector (max. peak, min. peak, sample, etc.)
- frequency deviation at a maximum of 1001 points within the set sweep limits (corresponds to a doubling of the span)

Differences in level settings between the reference trace and the current instrument settings are taken into account automatically. If the span is reduced, a linear interpolation of the intermediate values is applied. If the span increases, the values at the left or right border of the reference dataset are extrapolated to the current start or stop frequency, i.e. the reference dataset is extended by constant values.

Thus, the instrument settings can be changed in a wide area without giving up normalization. This reduces the necessity to carry out a new normalization to a minimum.

If approximation becomes too poor, however, normalization is aborted and an error message is displayed (see "Displayed Information and Errors" on page 219).

The normalized trace in the display

The normalized reference trace is also displayed in the spectrum diagram, by default at the top of the diagram (= 100% of the window height). It is indicated by a red line labeled "NOR", followed by the current reference value. However, it can be shifted vertically to reflect an attenuation or gain caused by the measured DUT (see also "Shifting the reference line (and normalized trace)" on page 216).

Restoring the calibration settings

If the measurement settings no longer match the instrument settings with which the calibration was performed (indicated by the "APX" or no label next to "Ext.TG" in the channel bar), you can restore the calibration settings, which are stored with the reference dataset on the R&S FSWP.

Storing the normalized reference trace as a transducer factor

The (inverse) normalized reference trace can also be stored as a *transducer factor* for use in other R&S FSWP applications that do not support external generator control. The normalized trace data is converted to a transducer with unit dB and stored in a file with the specified name and the suffix `.trd` under `c:\r_s\instr\trd`. The frequency points are allocated in equidistant steps between the start and stop frequency.

This is useful, for example, to determine the effects of a particular device component and then remove these effects from a subsequent measurement which includes this component.

For an example see "How to Remove the Effects of a Particular Component from Measurement Results Using Calibration" on page 228.

Note that the *normalized* measurement data is stored, not the original *reference* trace! Thus, if you store the normalized trace directly after calibration, without changing any settings, the transducer factor will be 0 dB for the entire span (by definition of the normalized trace).

Reference Trace, Reference Line and Reference Level

Reference trace

The calibration results are stored internally on the R&S FSWP as a *reference trace*. For each measured sweep point the offset to the expected values is determined. If normalization is activated, the offsets in the reference trace are removed from the current measurement results to compensate for the inherent distortions.

Reference line

The reference line is defined by the Reference Value and Reference Position in the "External Generator" > "Source Calibration" settings. It is similar to the Reference Level defined in the "Amplitude" settings. However, as opposed to the reference *level*,

this reference *line* only affects the y-axis scaling in the diagram, it has no effect on the expected input power level or the hardware settings.

The reference line determines the range and the scaling of the y-axis, just as the reference level does.

The normalized reference trace (0 dB directly after calibration) is displayed on this reference line, indicated by a red line in the diagram. By default, the reference line is displayed at the top of the diagram. If you shift the reference line, the normalized trace is shifted, as well.

Shifting the reference line (and normalized trace)

You can shift the reference line - and thus the normalized trace - in the result display by changing the Reference Position or the Reference Value.

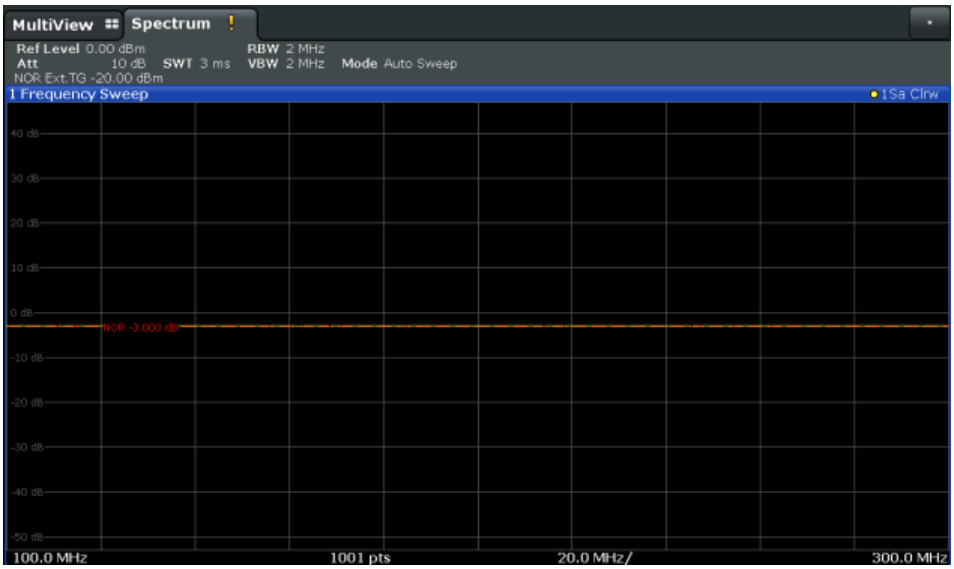


Fig. 3-7: Shifted reference line

If the DUT inserts a gain or an attenuation in the measurement, this effect can be reflected in the result display on the R&S FSWP. To reflect a power offset in the measurement trace, change the Reference Value.

For a detailed example see chapter 3.2.4.5, "Measurement Example: Calibration with an External Generator", on page 229.

Coupling the Frequencies

As described in "Normalization" on page 214, normalized measurement results are very accurate *as long as the same settings are used as for calibration*. Although approximate normalization is possible, it is important to consider the required frequencies for calibration in advance. The frequencies and levels supported by the connected signal generator are provided for reference with the interface configuration.

Two different methods are available to define the frequencies for calibration, that is to couple the frequencies of the R&S FSWP with those of the signal generator:

- **Manual coupling**: a single frequency is defined

- **Automatic coupling**: a series of frequencies is defined (one for each sweep point), based on the current frequency at the RF input of the R&S FSWP; the RF frequency range covers the currently defined span of the R&S FSWP (unless limited by the range of the signal generator)

Automatic coupling

If automatic coupling is used, the output frequency of the generator (source frequency) is calculated as follows:

$$\text{Source Freq} = \text{RF} \cdot \frac{\text{Numerator}}{\text{Denominator}} + \text{Offset}$$

Output frequency of the generator (3 - 1)

where:

$F_{Generator}$ = output frequency of the generator

$F_{Analyzer}$ = current frequency at the RF input of the R&S FSWP

Numerator = multiplication factor for the current analyzer frequency

Denominator = division factor for the current analyzer frequency

F_{Offset} = frequency offset for the current analyzer frequency, for example for frequency-converting measurements or harmonics measurements

The value range for the offset depends on the selected generator. The default setting is 0 Hz. Offsets other than 0 Hz are indicated by the "FRQ" label in the channel bar (see also "Displayed Information and Errors" on page 219).

Swept frequency range

The $F_{Analyzer}$ values for the calibration sweep start with the start frequency and end with the stop frequency defined in the "Frequency" settings of the R&S FSWP. The resulting output frequencies (Result Frequency Start and Result Frequency Stop) are displayed in the "External Generator" > "Measurement Configuration" for reference.

If the resulting frequency range exeeds the allowed ranges of the signal generator, an error message is displayed (see "Displayed Information and Errors" on page 219) and the Result Frequency Start and Result Frequency Stop values are corrected to comply with the range limits.

The calibration sweep nevertheless covers the entire span defined by the R&S FSWP; however, no input is received from the generator outside the generator's defined limits.

TTL synchronization

Some Rohde & Schwarz signal generators support TTL synchronization when connected via GPIB. The TTL interface is included in the AUX CONTROL connector of the External Generator Control option.

When pure GPIB connections are used between the R&S FSWP and the signal generator, the R&S FSWP sets the generator frequency for each frequency point individually

via GPIB, and only when the setting procedure is finished, the R&S FSWP can measure the next sweep point.

For generators with a TTL interface, the R&S FSWP sends a list of the frequencies to be set to the generator before the beginning of the first sweep. Then the R&S FSWP starts the sweep and the next frequency point is selected by both the R&S FSWP and the generator using the TTL handshake line "TRIGGER". The R&S FSWP can only measure a value when the generator signals the end of the setting procedure via the "BLANK" signal.

Using the TTL interface allows for considerably higher measurement rates than pure GPIB control, because the frequency stepping of the R&S FSWP is directly coupled with the frequency stepping of the generator.

Reverse sweep

The frequency offset for automatic coupling can be used to sweep in the reverse direction. To do so, define a negative offset in the external generator measurement configuration. (Note that the frequency is defined as the unsigned value of the equation, thus a negative frequency is not possible.)

Example: Example for reverse sweep

$F_{AnalyzerStart}$= 100 MHz

$F_{AnalyzerStop}$ = 200 MHz

F_{Offset} = -300 MHz

Numerator = Denominator = 1

→$F_{GeneratorStart}$ = 200 MHz

→$F_{GeneratorStop}$ = 100 MHz

If the offset is adjusted so that the sweep of the generator crosses the minimum generator frequency, a message is displayed in the status bar ("Reverse Sweep via min. Ext. Generator Frequency!").

Example: Example for reverse sweep via minimum frequency

$F_{AnalyzerStart}$= 100 MHz

$F_{AnalyzerStop}$ = 200 MHz

F_{Offset} = -150 MHz

F_{min} = 20 MHz

Numerator = Denominator = 1

→$F_{GeneratorStart}$ = 50 MHz

→$F_{GeneratorStop}$ = 50 MHz via Fmin

Displayed Information and Errors

Channel bar

If external generator control is active, some additional information is displayed in the channel bar.

Label	Description
EXT TG: <source power>	External generator active; signal sent with <source power> level
LVL	Power Offset (see "Source Offset" on page 223
FRQ	Frequency Offset (see "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 223
NOR	Normalization on; No difference between reference setting and measurement
APX (approximation)	Normalization on; Deviation from the reference setting occurs
-	Aborted normalization or no calibration performed yet

Error and status messages

The following status and error messages may occur during external generator control.

Message	Description
"Ext. Generator GPIB Handshake Error!" / "Ext. Generator TCPIP Handshake Error!" / "Ext. Generator TTL Handshake Error!"	Connection to the generator is not possible, e.g. due to a cable damage or loose connection or wrong address.
"Ext. Generator Limits Exceeded!"	The allowed frequency or power ranges for the generator were exceeded.
"Reverse Sweep via min. Ext. Generator Frequency!"	Reverse sweep is performed; frequencies are reduced to the minimum frequency, then increased again; see "Reverse sweep" on page 218
"Ext. Generator File Syntax Error!"	Syntax error in the generator setup file (see "Generator Setup Files" on page 213
"Ext. Generator Command Error!"	Missing or wrong command in the generator setup file (see "Generator Setup Files" on page 213
"Ext. Generator Visa Error!!"	Error with Visa driver provided with installation (very unlikely)

NOTICE

Overloading

At a reference level of -10 dBm and at a external generator output level of the same value, the R&S FSWP operates without overrange reserve. That means the R&S FSWP is in danger of being overloaded if a signal is applied whose amplitude is higher than the reference line. In this case, either the message "RF OVLD" for overload or "IF OVLD" for exceeded display range (clipping of the trace at the upper diagram border = overrange) is displayed in the status line.

Overloading can be avoided as follows:

- Reducing the output level of the external generator ("Source Power" on page 223 in "External Generator > Measurement Configuration")
- Increasing the reference level (Reference Level in the "Amplitude" menu)

3.2.4.3 External Generator Control Settings

The "External Generator" settings are available in the "Input" dialog box if the R&S FSWP External Generator Control option is installed. For each measurement channel one external generator can be configured. To switch between different configurations define multiple measurement channels.

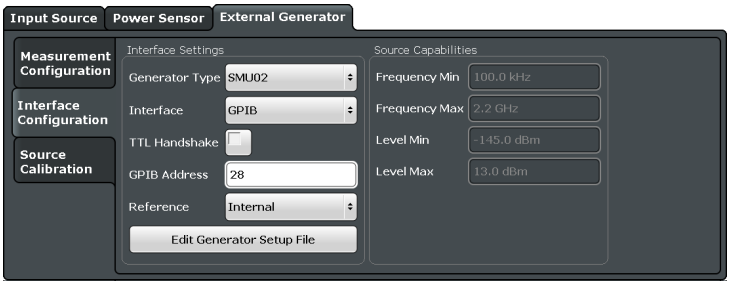
To display this dialog box, press the INPUT/OUPUT key and then select "External Generator Config".

For more information on external generator control see chapter 3.2.4.2, "Basics on External Generator Control", on page 208.

- Interface Configuration Settings....220
- Measurement Settings....222
- Source Calibration Functions....224

Interface Configuration Settings

The interface settings for the connection to the external generator are defined in the "Interface Configuration" subtab of the "External Generator" tab.



Generator Type....221
Interface....221
TTL Handshake....221
GPIB Address / TCP/IP Address....221
Reference....221

Edit Generator Setup File....222
Frequency Min. / Frequency Max....222
Level Min. / Level Max....222

Generator Type
Selects the generator type and thus defines the generator setup file to use.

For an overview of supported generators see "Overview of Supported Generators" on page 211. For information on generator setup files see "Generator Setup Files" on page 213.

Remote command:
`SYSTem:COMMunicate:RDEVice:GENerator:TYPE` on page 565

Interface
Type of interface connection used. The following interfaces are currently supported:

- GPIB
- TCP/IP (not by all generators)

For details on which signal generators support which interfaces, see the documentation of the corresponding signal generator.

Remote command:
`SYSTem:COMMunicate:RDEVice:GENerator:INTerface` on page 564

TTL Handshake
If available for the specified generator type, this option activates TTL synchronization via handshake for GPIB connections.

Using the TTL interface allows for considerably higher measurement rates than pure GPIB control, because the frequency stepping of the R&S FSWP is directly coupled with the frequency stepping of the generator.

For more information on TTL synchronization see "TTL synchronization" on page 217.

For an overview of which generators support TTL synchronization see "Overview of Supported Generators" on page 211.

Remote command:
`SYSTem:COMMunicate:RDEVice:GENerator:LINK` on page 564

GPIB Address / TCP/IP Address
For LAN connections: TCP/IP address of the signal generator

For GPIB connections: GPIB address of the signal generator.

Remote command:
`SYSTem:COMMunicate:GPIB:RDEVice:GENerator:ADDRess` on page 564
`SYSTem:COMMunicate:TCPip:RDEVice:GENerator:ADDRess` on page 565

Reference
Selects the internal R&S FSWP or an external frequency reference to synchronize the R&S FSWP with the generator (default: internal).

Remote command:
`SOURce:EXTernal:ROSCillator[:SOURce]` on page 563

Edit Generator Setup File
Displays the setup file for the currently selected Generator Type in read-only mode in an editor.

Although the existing setup files are displayed in read-only mode in the editor, they can be saved under a different name (using "File > SaveAs").

Be careful, however, to adhere to the required syntax and commands. Errors will only be detected and displayed when you try to use the new generator (see also "Displayed Information and Errors" on page 219).

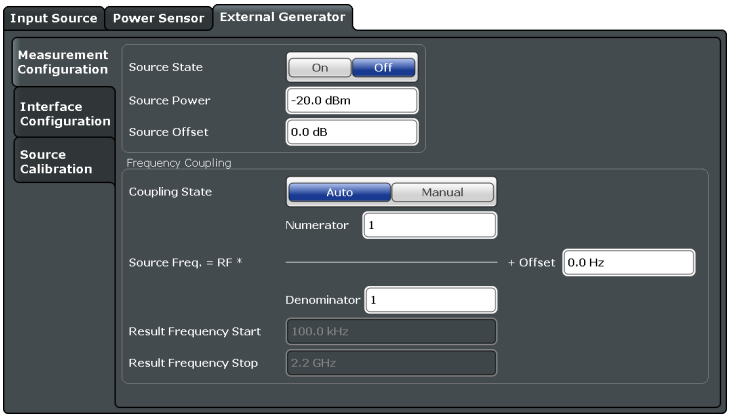
For details see "Generator Setup Files" on page 213.

Frequency Min. / Frequency Max.
For reference only: Lower and upper frequency limit for the generator.

Level Min. / Level Max.
For reference only: Lower and upper power limit for the generator.

Measurement Settings

The measurement settings for external generator control are configured in the "Measurement Configuration" subtab of the "External Generator" tab.



Source State..... 222
Source Power..... 223
Source Offset..... 223
Source Frequency Coupling..... 223
(Manual) Source Frequency..... 223
(Automatic) Source Frequency (Numerator/Denominator/Offset)..... 223
Result Frequency Start..... 224
Result Frequency Stop..... 224

Source State
Activates or deactivates control of an external generator.

Remote command:
`SOURce:EXTernal[:STATe]` on page 563

Source Power
The output power of the external generator. The default output power is -20 dBm. The range is specified in the data sheet.

Remote command:
`SOURce:EXTernal:POWer[:LEVel]` on page 563

Source Offset
Constant level offset for the external generator. Values from -200 dB to +200 dB in 1 dB steps are allowed. The default setting is 0 dB. Offsets are indicated by the "LVL" label in the channel bar (see also "Displayed Information and Errors" on page 219).

With this offset, attenuators or amplifiers at the output connector of the external generator can be taken into account for the displayed output power values on screen or during data entry, for example. Positive offsets apply to an amplifier and negative offsets to an attenuator subsequent to the external generator.

Remote command:
`SOURce:POWer[:LEVel][:IMMediate]:OFFSet` on page 563

Source Frequency Coupling
Defines the frequency coupling mode between the R&S FSWP and the generator.

For more information on coupling frequencies see "Coupling the Frequencies" on page 216.

"Auto" Default setting: a series of frequencies is defined (one for each sweep point), based on the current frequency at the RF input of the R&S FSWP (see "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 223); the RF frequency range covers the currently defined span of the R&S FSWP (unless limited by the range of the signal generator)

"Manual" The generator uses a single fixed frequency, defined by (Manual) Source Frequency which is displayed when you select "Manual" coupling.

Remote command:
`SOURce:EXTernal:FREQuency:COUPling[:STATe]` on page 561

(Manual) Source Frequency
Defines the fixed frequency to be used by the generator.

Remote command:
`SOURce:EXTernal:FREQuency` on page 560

(Automatic) Source Frequency (Numerator/Denominator/Offset)
With automatic frequency coupling, a series of frequencies is defined (one for each sweep point), based on the current frequency at the RF input of the R&S FSWP.

However, the frequency used by the generator may differ from the input from the R&S FSWP. The RF frequency may be multiplied by a specified factor, or a frequency offset can be added, or both.

Note: The input for the generator frequency is not validated, i.e. you can enter any values. However, if the allowed frequency ranges of the generator are exceeded, an error

message is displayed on the R&S FSWP and the values for Result Frequency Start and Result Frequency Stop are corrected to comply with the range limits.

The value range for the offset depends on the selected generator. The default setting is 0 Hz. Offsets <> 0 Hz are indicated by the "FRQ" label in the channel bar. Negative offsets can be used to define reverse sweeps.

For more information on coupling frequencies and reverse sweeps see "Coupling the Frequencies" on page 216. For more information on error messages and the channel bar see "Displayed Information and Errors" on page 219.

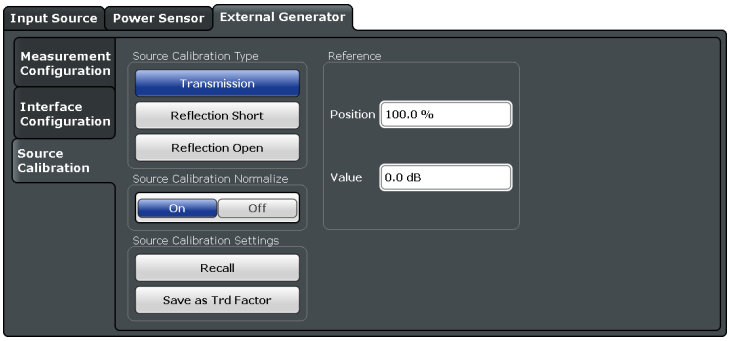
Remote command:
`SOURce:EXTernal:FREQuency[:FACTor]:DENominator` on page 561
`SOURce:EXTernal:FREQuency[:FACTor]:NUMerator` on page 562
`SOURce:EXTernal:FREQuency:OFFSet` on page 562

Result Frequency Start
For reference only: The start frequency for the generator, calculated from the configured generator frequency and the start value defined for the R&S FSWP.

Result Frequency Stop
For reference only: The stop frequency for the generator, calculated from the configured generator frequency and the stop value defined for the R&S FSWP.

Source Calibration Functions

The calibration functions of the external generator are available in the "Source Calibration" subtab of the "External Generator" tab, but *only if external generator control is active* (see "Source State" on page 222).



Calibrate Transmission 224
Calibrate Reflection Short 225
Calibrate Reflection Open 225
Source Calibration Normalize 225
Recall 225
Save As Trd Factor 226
Reference Position 226
Reference Value 226

Calibrate Transmission
Starts a transmission type measurement to determine a reference trace. This trace is used to calculate the difference for the normalized values.

For details see "Calibration Mechanism" on page 213.

Remote command:
[SENSe:]CORRection:METHod on page 559

Calibrate Reflection Short
Starts a short-circuit reflection type measurement to determine a reference trace for calibration.

If both calibrations (open circuit, short circuit) are carried out, the calibration trace is calculated by averaging the two measurements. The order of the two calibration measurements is irrelevant.

Remote command:
[SENSe:]CORRection:METHod on page 559
Selects the reflection method.
[SENSe:]CORRection:COLLect[:ACQuire] on page 558
Starts the sweep for short-circuit calibration.

Calibrate Reflection Open
Starts an open-circuit reflection type measurement to determine a reference trace for calibration.

If both reflection-type calibrations (open circuit, short circuit) are carried out, the reference trace is calculated by averaging the two measurements. The order of the two calibration measurements is irrelevant.

Remote command:
[SENSe:]CORRection:METHod on page 559
Selects the reflection method.
[SENSe:]CORRection:COLLect[:ACQuire] on page 558
Starts the sweep for open-circuit calibration.

Source Calibration Normalize
Switches the normalization of measurement results on or off. This function is only available if the memory contains a reference trace, that is, after a calibration has been performed.

For details on normalization see "Normalization" on page 214.

Remote command:
[SENSe:]CORRection[:STATe] on page 560

Recall
Restores the settings that were used during source calibration. This can be useful if instrument settings were changed after calibration (e.g. center frequency, frequency deviation, reference level, etc).

Remote command:
[SENSe:]CORRection:RECall on page 559

Save As Trd Factor
Uses the normalized measurement data to generate a transducer factor. The trace data is converted to a transducer with unit dB and stored in a file with the specified name and the suffix `.trd` under "`c:\r_s\instr\trd`". The frequency points are allocated in equidistant steps between start and stop frequency. The generated transducer factor can be further adapted using the "Transducer" softkey in the SETUP menu.

This function is only available if Source Calibration Normalize is switched on.

Note: Note that the *normalized* measurement data is used, not the *reference* trace! Thus, if you store the normalized trace directly after calibration, without changing any settings, the transducer factor will be 0 dB for the entire span (by definition of the normalized trace).

Remote command:
`[SENSe:]CORRection:TRANsducer:GENerator` on page 560

Reference Position
Defines the position of the Result Frequency Stop in percent of the total y-axis range. The top of the diagram is 100%, the bottom is 0%. By default, the 0 dB line is displayed at the top of the diagram (100%).

This setting is only available if normalization is on (see "Source Calibration Normalize" on page 225).

The reference line defined by the reference value and reference position is similar to the Reference Level defined in the "Amplitude" settings. However, this reference line only affects the y-axis scaling in the diagram, it has no effect on the expected input power level or the hardware settings.

The normalized trace (0 dB directly after calibration) is displayed on this reference line, indicated by a red line in the diagram. If you shift the reference line, the normalized trace is shifted, as well.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 579

Reference Value
Defines the reference value to be displayed at the specified Result Frequency Start.

This setting can be used to shift the reference line and thus the normalized trace, similar to the Shifting the Display (Offset) defined in the "Amplitude" settings shifts the reference level *in the display*.

Shifting the normalized trace is useful, for example, to reflect an attenuation or gain caused by the measured DUT. If you then zoom into the diagram around the normalized trace, the measured trace still remains fully visible.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue` on page 579

3.2.4.4 How to Work With External Generator Control

The following step-by-step instructions demonstrate how to work with the optional External Generator Control.

- How to Calibrate a Measurement Setup using an External Generator..... 227
- How to Remove the Effects of a Particular Component from Measurement Results Using Calibration.....228
- How to Compensate for Additional Gain or Attenuation after Calibration..... 229

How to Calibrate a Measurement Setup using an External Generator

1. Connect the signal generator's GPIB interface connector to the EXT. GEN.CONTROL GPIB connector on the rear panel of the R&S FSWP.
2. Connect the signal generator output to the RF INPUT connector of the R&S FSWP.
3. If the signal generator supports TTL synchronization, connect the signal generator to the optionalAUX.CONTROL port.
4. If the measurement setup does not require the full span of the R&S FSWP, change the "Frequency Start" and "Frequency Stop" values (FREQ key > "Frequency Config" softkey).
5. Press the INPUT/OUTPUT key and select "External Generator Config".
6. In the "Interface Configuration" subtab, select the "Generator Type" connected to the R&S FSWP.
   If the required generator type is not available, define a new setup file as described in "To define a new generator setup file" on page 228.
7. Select the type of interface and the address used to connect the generator to the R&S FSWP.
8. If the generator supports "TTL Synchronization", activate this function.
9. Select "Reference: External" to synchronize the analyzer with the generator.
10. Switch to the "Measurement Configuration" subtab.
11. Set the "Source State" to "On".
12. Define the generator output level as the "Source Power".
13. Optionally, to define a constant level offset for the external generator, define a "Source Offset".
14. The default frequency list for the calibration sweep contains 1001 values, divided in equi-distant frequencies between the R&S FSWP's start and stop frequency. For most cases, this automatic coupling should be correct. Check the "Result Frequency Start" and "Result Frequency Stop" values to make sure the required measurement span is covered. If necessary, change the frequency settings on the R&S FSWP (FREQ key > "Frequency Config" softkey), or use a different generator type.

15. Switch to the "Source Calibration" subtab.
16. Select the "Source Calibration Type": "Transmission" to perform a calibration sweep and store a reference trace for the measurement setup.
17. Select "Source Calibration Normalize": "On".
18. Optionally, shift the reference line further down in the result display by descreasing the "Reference": "Position".

    The measurement setup is now calibrated. Subsequent measurement results are normalized, so that any unwanted effects from the cables and connectors are removed.

To define a new generator setup file

1. Press the INPUT/OUTPUT key and select "External Generator Config".
2. In the "Interface Configuration" subtab, select a generator type that has similar characteristics (frequency and power ranges).
3. Select "Edit Generator Setup File".
   The configuration file for the selected generator type is displayed (read-only) in an editor.
4. Edit the configuration values according to your generator. Be sure not to change the syntax of the file - only change the *values* of the parameters.
   Errors will only be detected and displayed when you try to use the new generator (see also "Displayed Information and Errors" on page 219).
5. Save the file under a different name with the extension `.gen`:
   a) In the editor, select "File > SaveAs".
   b) Select "Save as type: All Files (*.*)".
   c) Specify a name with the extension `.gen`.
6. In the R&S FSWP firmware, close the "External Generator Config" dialog and re-open it.

   Now you can select the new generator type from the selection list on the "Interface Configuration" tab.

How to Remove the Effects of a Particular Component from Measurement Results Using Calibration

1. Set up the measurement, including the component, and perform a calibration as described in "How to Calibrate a Measurement Setup using an External Generator" on page 227.
2. After setting "Source Calibration Normalize": "On", select "Save as Trd Factor" to store the normalized reference trace as a transducer factor.
3. If necessary, switch to another measurement channel for a different R&S FSWP application.

4. Press the SETUP key, then select the "Transducer" softkey.
5. Select the stored transducer in the list of available transducers and select the "Active" setting for it.
6. Perform any measurement with the setup that contains the calibrated component.

   The measurement results do not include the effects from the component.

How to Compensate for Additional Gain or Attenuation after Calibration

If a gain or an attenuation is inserted in the measurement after calibration, this effect can be reflected in the display of the normalized trace on the R&S FSWP. Thus, the measured trace and the normalized trace are not so far apart in the display, so that you can zoom into the normalized trace without cropping the measurement trace.

Prerequisite: a calibration has been performed for the original measurement setup, except for the component causing an additional gain or attenuation (as described in "How to Calibrate a Measurement Setup using an External Generator" on page 227)

1. Insert the additional component in the calibrated measurement setup and perform a new measurement.
2. Press the INPUT/OUTPUT key and select "External Generator Config".
3. Switch to the "Source Calibration" subtab.
4. With active normalization, set the "Reference":"Value" to the same value as the gain or attenuation the inserted component causes.
5. Optionally, shift the reference line further down in the result display by decreasing the "Reference": "Position".

   The normalized reference trace moves to the position of the measured trace.
6. Optionally, zoom into the measured trace by changing the y-axis scaling (or the range: "AMPT > Scale Config > Range").

   The measured trace is still fully visible, and the absolute values are still valid.

3.2.4.5 Measurement Example: Calibration with an External Generator

The following measurement example demonstrates the most common functions using an external generator. This example requires the External Generator Control option.

The example assumes an SMW100A generator is connected to the R&S FSWP. A band elimination filter is the device under test. After calibration, an additional attenuator is inserted between the DUT and the R&S FSWP.

The following procedures are described:

- "Calibrating the measurement setup" on page 230
- "Measuring the effects of the DUT" on page 231
- "Compensating the effects of additional attenuation after calibration" on page 233

Calibrating the measurement setup

1. Connect the signal generator's GPIB interface connector to the EXT. GEN.CONTROL GPIB connector on the rear panel of the R&S FSWP.
2. Connect the signal generator output to the RF INPUT connector of the R&S FSWP.
3. Adapt the measurement range of the R&S FSWP to the filter to be tested. In this measurement, define the following settings:
   a) Press the FREQ key, select "Frequency Config" and enter "Frequency Start": *100 MHz*.
   b) Enter "Frequency Stop": *300 MHz*
4. Press the INPUT/OUTPUT key and select "External Generator Config".
5. In the "Interface Configuration" sub-tab, select "Generator Type":"SMW06".
6. Select "Reference: External" to synchronize the analyzer with the generator.
7. Switch to the "Measurement Configuration" sub-tab.
8. Set the "Source State" to "On".
9. Define the generator output level as the "Source Power": *-20 dBm*.
10. Set the "Coupling State" to "Auto".

    The "Result Frequency Start" value for the generator is indicated as *100.0 MHz*.
    The "Result Frequency Stop" value is indicated as *300.0 MHz*.
11. Switch to the "Source Calibration" sub-tab.
12. Select the "Source Calibration Type": "Transmission" to perform a calibration sweep and store a reference trace for the measurement setup.

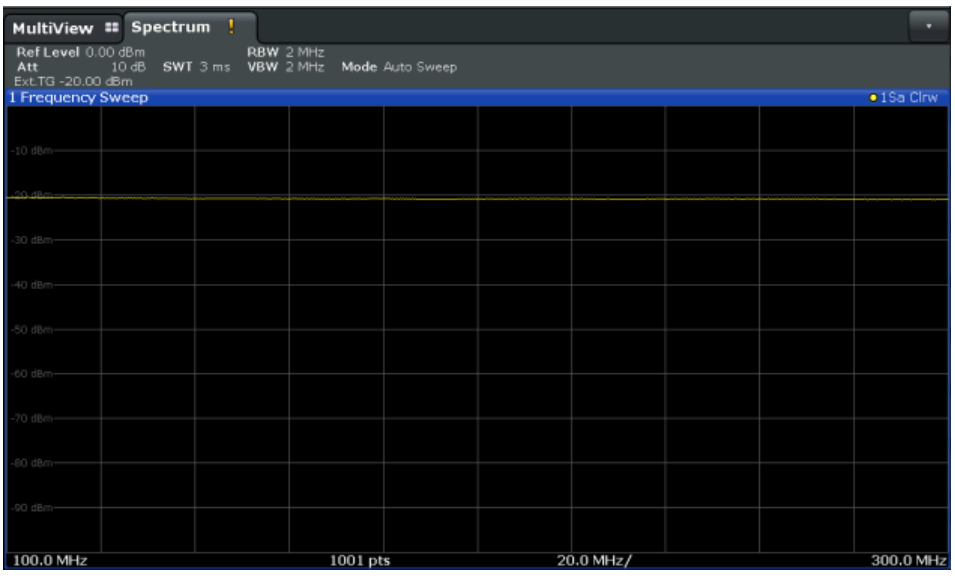


Fig. 3-8: Measurement results from generator, analyzer and connecting cables

13. Select "Source Calibration Normalize": "On" to set the measurement results for the current setup to 0, thus eliminating all effects from the generator, the analyzer and the connecting cables from subsequent measurements with the band elimination filter.

    The reference line is displayed at 0 dB at the top of the diagram (100%).

Fig. 3-9: Normalized measurement results after calibration

Measuring the effects of the DUT

After calibration we can insert the band elimination filter (our DUT) in the measurement setup.

1. Connect the signal generator output to the band elimination filter.
2. Connect the band elimination filter output to the RF INPUT connector of the R&S FSWP.

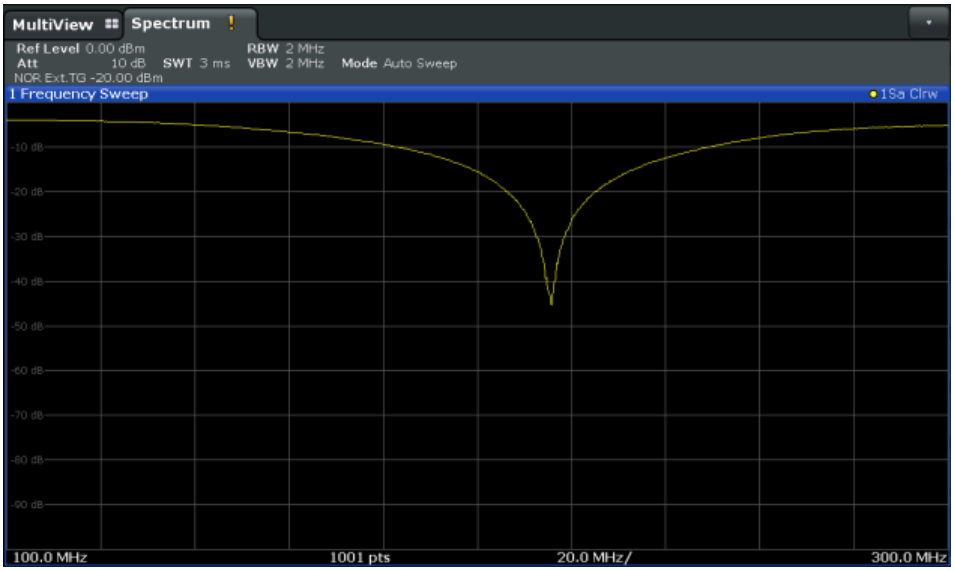


Fig. 3-10: Band elimination filter results

3. Shift the reference line from the top of the diagram to the middle of the diagram by changing the position of the reference point *0.0 dB* to *50 %*.
   In the "Source Calibration" tab, enter "Position": *50 %*.

   At the same time, the range of the displayed y-axis moves from *[-100.0 dB to 0 dB]* to *[-50 dB to +50 dB]*.

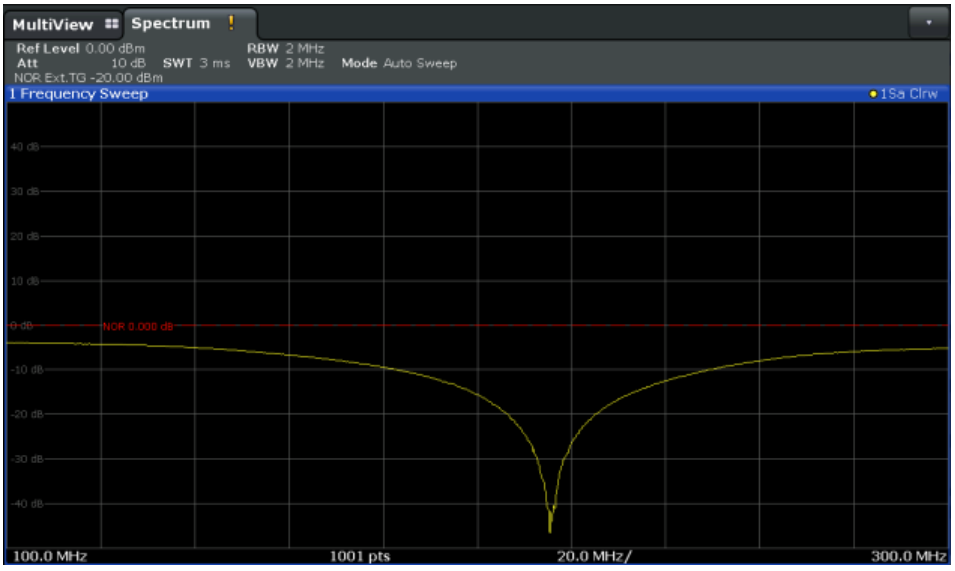


Fig. 3-11: Reference line shifted to middle of diagram (50%)

Compensating the effects of additional attenuation after calibration

After calibration, an additional attenuator is inserted between the DUT and the R&S FSWP. This may be necessary, for example, to protect the analyzer's input connector. Nevertheless, we are only interested in the effects of the DUT, not those of the additional protective attenuator. Thus, we will compensate these effects in the result display on the R&S FSWP by moving the reference line.

1. Connect a 3 dB attenuator between the band elimination filter output and the RF INPUT connector on the R&S FSWP.

   The measurement results are now 3 dB lower.

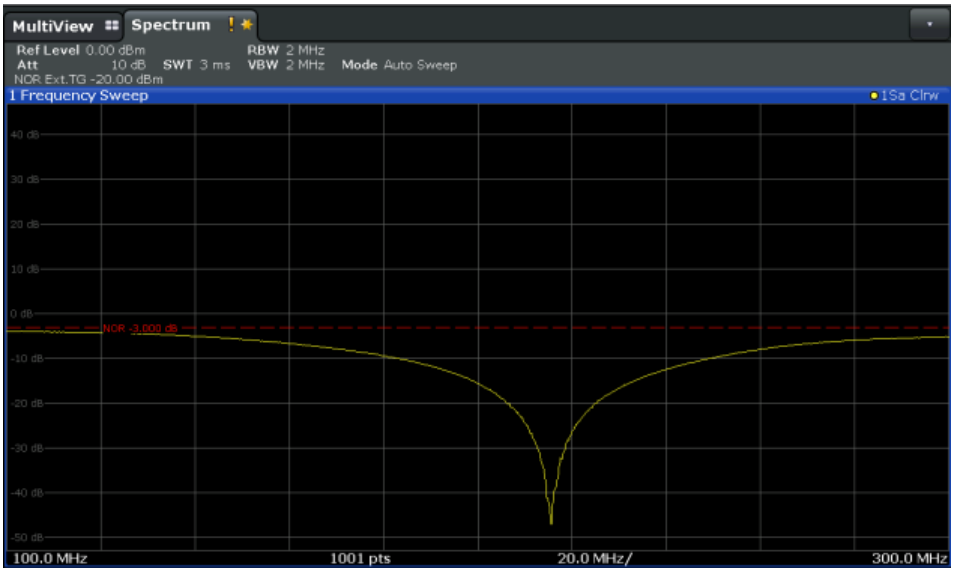


Fig. 3-12: Measurement results with additional attenuator

2. In the "Source Calibration" tab, enter "Reference Value":*-3 dB*.

   The reference line is shifted down by 3 dB so that the measurement trace is displayed on the reference line again.
   At the same time, the scaling of the y-axis is changed: -3 dB are now shown at 50% of the diagram; the range is *[-53 dB to +47 dB*].

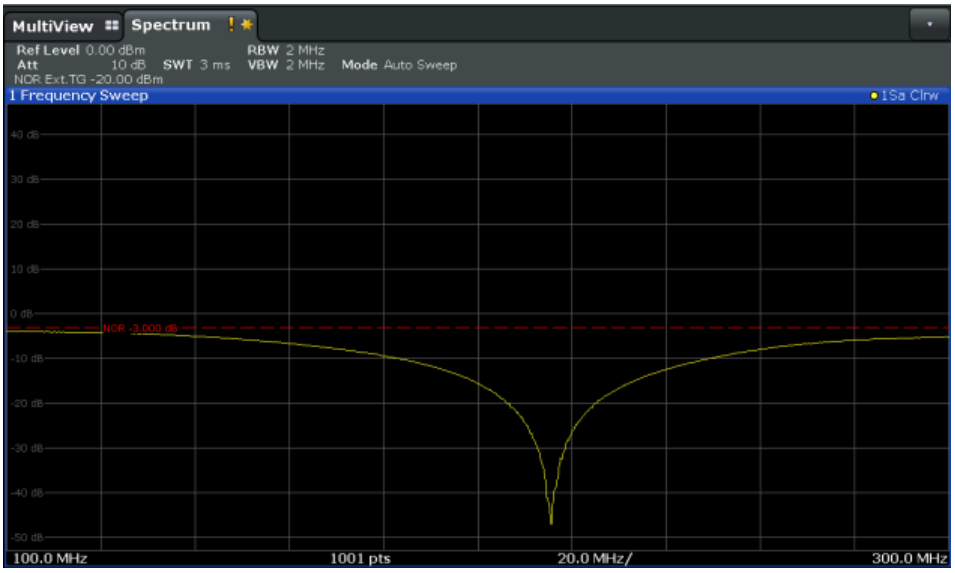


Fig. 3-13: Reference line with an offset of -3 dB and shifted to middle of diagram (50%)

3. After the reference trace has been shifted, you can zoom into the measured trace to determine the offsets to the reference line, which represent the effects of the band elimination filter in the measurement setup.
   Change the y-axis scaling to 1 dB/div (or the range to 10 dB).
   a) Press the AMPT key, then select "Scale Config" > "Range".
   b) Enter *10 dB*.

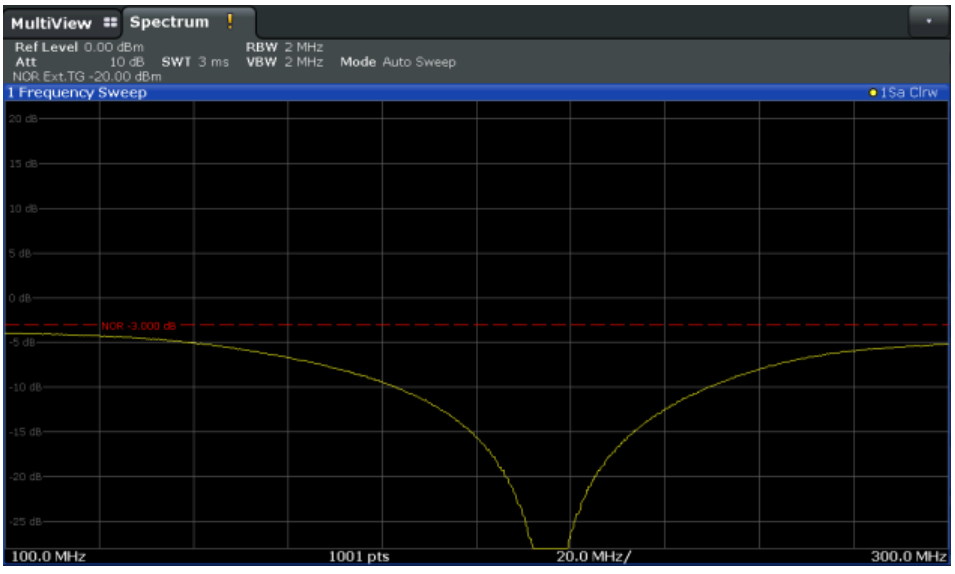


Fig. 3-14: Reference line with measurement results using larger scale

3.2.5 Output Settings

The R&S FSWP can provide output to special connectors for other devices.

For details on connectors refer to the R&S FSWP Getting Started manual, "Front / Rear Panel View" chapters.

- General Output Configuration....235
- DC Power Output Configuration....237
- Signal Source Output Configuration....237

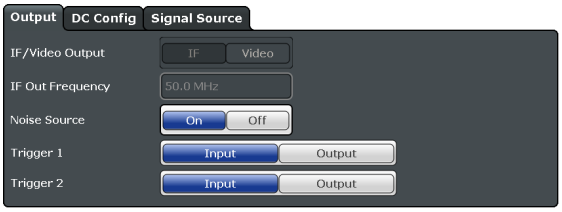
3.2.5.1 General Output Configuration

To configure general output

Output settings can be configured via the "Output" dialog box.

► To display the "Output" dialog box, do one of the following:

- Select "Output" from the "Overview".
- Select the INPUT/OUTPUT key, the "Output Config" softkey and the "Output" tab.



Providing trigger signals as output is described in chapter 3.6.4, "How to Output a Trigger Signal", on page 288.

IF/Video Output....235
IF (Wide) Out Frequency....236
Noise Source....236
Trigger 1/2....236
└ Output Type....236
└ Level....237
└ Pulse Length....237
└ Send Trigger....237

IF/Video Output
Defines the type of signal available at the IF/VIDEO/DEMOD on the rear panel of the R&S FSWP.

For restrictions and additional information see chapter 3.2.1.4, "IF and Video Signal Output", on page 196.

"IF" The measured IF value is available at the IF/VIDEO/DEMOD output connector.

"VIDEO" The displayed video signal (i.e. the filtered and detected IF signal) is available at the IF/VIDEO/DEMOD output connector.
This setting is required to provide demodulated audio frequencies at the output.

Remote command:
`OUTPut:IF[:SOURce]` on page 566

IF (Wide) Out Frequency
Defines or indicates the frequency at which the IF signal level is provided at the IF/VIDEO/DEMOD connector if IF/Video Output is set to "IF".

Note: The IF output frequency of the **IF WIDE OUTPUT** connector cannot be defined manually, but is determined automatically depending on the center frequency. It is indicated in this field when the IF WIDE OUTPUT connector is used. For details on the used frequencies see the data sheet.

For more information see chapter 3.2.1.4, "IF and Video Signal Output", on page 196.

Remote command:
`OUTPut:IF:IFFRequency` on page 566

Noise Source
Switches the supply voltage for an external noise source on or off.

External noise sources are useful when you are measuring power levels that fall below the noise floor of the R&S FSWP itself, for example when measuring the noise level of a DUT.

For details see chapter 3.2.1.2, "Input from Noise Sources", on page 195

Remote command:
`DIAGnostic:SERVice:NSOurce` on page 566

Trigger 1/2
Access: "Overview" > "Trigger" > "Trigger In/Out"

Defines the usage of the variable TRIGGER INPUT/OUTPUT connectors, where:

"Trigger 1": TRIGGER INPUT/OUTPUT connector on the front panel

"Trigger 2": TRIGGER INPUT/OUTPUT connector on the front panel

"Input" The signal at the connector is used as an external trigger source by the R&S FSWP. Trigger input parameters are available in the "Trigger" dialog box.

"Output" The R&S FSWP sends a trigger signal to the output connector to be used by connected devices.
Further trigger parameters are available for the connector.

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 567
`OUTPut:TRIGger<port>:DIRection` on page 567

Output Type ← Trigger 1/2
Type of signal to be sent to the output

"Device Triggered"	(Default) Sends a trigger when the R&S FSWP triggers.
"Trigger Armed"	Sends a (high level) trigger when the R&S FSWP is in "Ready for trigger" state. This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low level signal at the AUX port (pin 9).
"User Defined"	Sends a trigger when user selects "Send Trigger" button. In this case, further parameters are available for the output signal.

Remote command:
`OUTPut:TRIGger<port>:OTYPe` on page 567

Level ← Output Type ← Trigger 1/2
Defines whether a constant high (1) or low (0) signal is sent to the output connector.

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 567

Pulse Length ← Output Type ← Trigger 1/2
Defines the length of the pulse sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 568

Send Trigger ← Output Type ← Trigger 1/2
Sends a user-defined trigger to the output connector immediately. Note that the trigger pulse level is always opposite to the constant signal level defined by the output "Level" setting, e.g. for "Level = High", a constant high signal is output to the connector until the "Send Trigger" button is selected. Then, a low pulse is sent.

Which pulse level will be sent is indicated by a graphic on the button.

Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 568

3.2.5.2 DC Power Output Configuration

The configuration of the DC Power supply is the same as in the Phase Noise application.

For a comprehensive description, please refer to the R&S FSWP User Manual.

3.2.5.3 Signal Source Output Configuration

The configuration of the optional signal source is the same as in the Phase Noise application.

For a comprehensive description, please refer to the R&S FSWP User Manual.

3.3 Frequency and Span Configuration

The frequency and span settings define the scope of the signal and spectrum to be analyzed with the R&S FSWP.

- Impact of the Frequency and Span Settings....238
- Frequency and Span Settings....240
- How To Define the Frequency Range....245
- How to Move the Center Frequency through the Frequency Range....246
- How to Keep the Center Frequency Stable....246

3.3.1 Impact of the Frequency and Span Settings

Some background knowledge on the impact of the described settings is provided here for a better understanding of the required configuration.

- Defining the Scope of the Measurement - Frequency Range....238
- Stepping Through the Frequency Range - Center Frequency Stepsize....238
- Keeping the Center Frequency Stable - Signal Tracking....239
- Coping with Large Frequency Ranges - Logarithmic Scaling....239

3.3.1.1 Defining the Scope of the Measurement - Frequency Range

The frequency range defines the scope of the signal and spectrum to be analyzed. It can either be defined as a span around a center frequency, or as a range from a start to a stop frequency. Furthermore, the full span comprising the entire possible frequency range can be selected, or a zero span. The full span option allows you to perform an overview measurement over the entire span. Using the "Last Span" function you can easily switch back to the detailed measurement of a specific frequency range.

For sinusoidal signals, the center frequency can be defined automatically by the R&S FSWP as the highest frequency level in the frequency span (see "Adjusting the Center Frequency Automatically (Auto Freq)" on page 289).

3.3.1.2 Stepping Through the Frequency Range - Center Frequency Stepsize

Using the arrow keys you can move the center frequency in discrete steps through the available frequency range. The step size by which the center frequency is increased or decreased is defined by the "Center Frequency Stepsize".

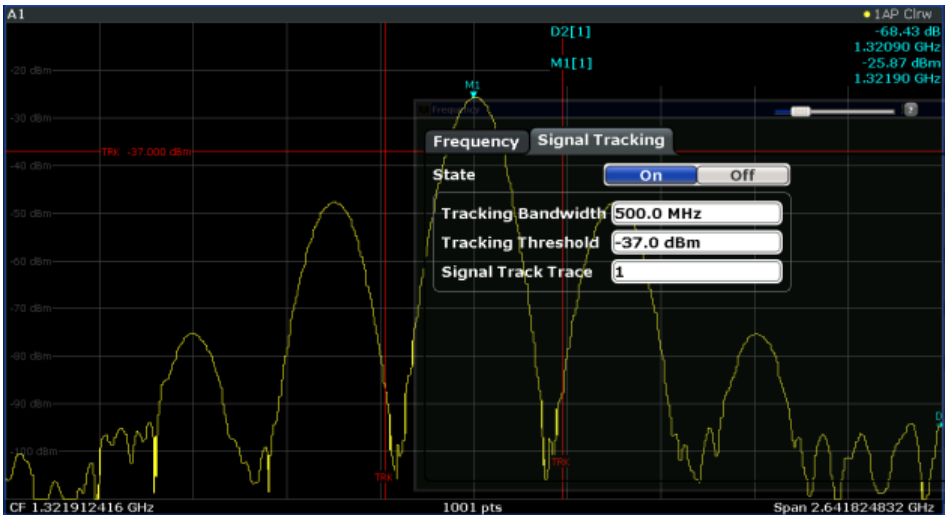
The "Center Frequency Stepsize" also defines the step size by which the value is increased or decreased when you use the rotary knob to change the center frequency; however, the **rotary knob** moves in steps of only **1/10 of the "Center Frequency Stepsize"** to allow for a more precise setting.

By default, the step size is set in relation to the selected span or resolution bandwidth (for zero span measurements). In some cases, however, it may be useful to set the step size to other values.

For example, to analyze signal harmonics, you can define the step size to be equal to the center frequency. In this case, each stroke of the arrow key selects the center frequency of another harmonic. Similarly, you can define the step size to be equal to the current marker frequency.

3.3.1.3 Keeping the Center Frequency Stable - Signal Tracking

If the signal drifts on the display but you want to keep the center frequency on the signal peak, the center frequency can be adjusted automatically using **signal tracking**. In this case, the signal trace is surveyed in a specified bandwidth around the expected center frequency. After each sweep, the center frequency is set to the maximum signal found within the searched bandwidth. If no maximum signal above a defined threshold value is found in the searched bandwidth, the center frequency remains unchanged. The search bandwidth and the threshold value are shown in the diagram by red lines which are labeled as "TRK".



3.3.1.4 Coping with Large Frequency Ranges - Logarithmic Scaling

In a linear display, the frequencies are distributed linearly across the x-axis. That means the entire frequency range is divided by the number of measurement points, and the distance between measurement points is equal. Linear scaling is useful to determine precise frequencies within a small range.

Fig. 3-15: Linear x-axis scaling: the distance between the measurement points is equal, e.g. 200 kHz

However, if high and low frequencies appear in the same display, it is difficult to determine individual frequencies precisely or to distinguish frequencies that are close together.

In a logarithmic display, lower frequencies are distributed among a much larger area of the display, while high frequencies are condensed to a smaller area. Now it is much easier to distinguish several lower frequencies, as they are spread over a wider area. Logarithmic scaling is useful for overview measurements when a large frequency range must be displayed in one diagram.

However, with logarithmic scaling, the frequency resolution between two measurement points deteriorates with higher frequencies.

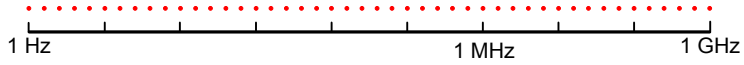
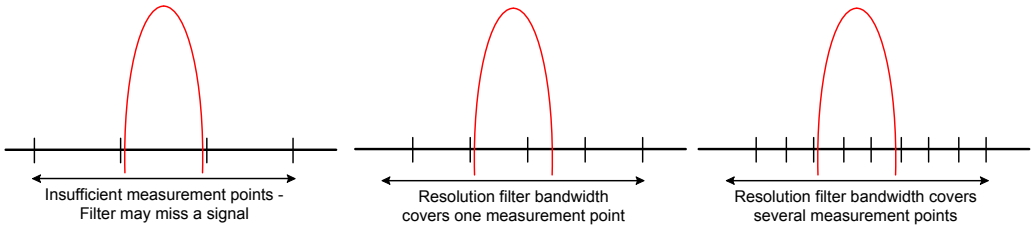


Fig. 3-16: Logarithmic x-axis scaling: the distance between measurement points is variable

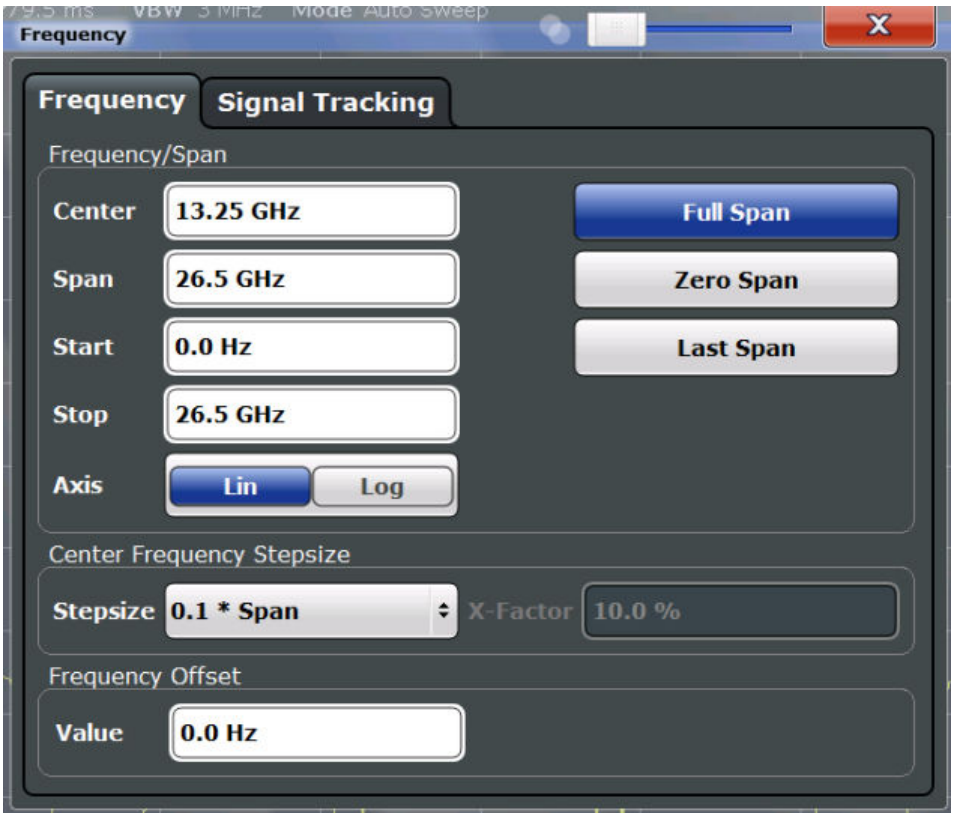
In the spectrum from 10 Hz to 100 Hz, the distance is a few Hz. Between 100 MHz and 1 GHz, the distance is several MHz.

Thus, for logarithmic x-axis scaling, the number of measurement points must be sufficiently high in order to distinguish high frequencies precisely. The resolution bandwidth should cover at least one measurement point (that means: the distance between two measurement points should not exceed the RBW). If this condition is not met, signals or interferers could be missed, especially narrowband interferers.



3.3.2 Frequency and Span Settings

Frequency and span settings can be configured via the "Frequency" dialog box. Signal tracking is configured in the "Signal Tracking" tab of this dialog box. For details see chapter 3.3.3, "How To Define the Frequency Range", on page 245.



Center frequency....242
Span....242
Start / Stop....242
Frequency Axis Scaling....242
Full Span....243

Zero Span 243
Last Span 243
Center Frequency Stepsize 243
Frequency Offset 244
Signal Tracking 244
└ Signal Tracking State 244
└ Tracking Bandwidth 245
└ Tracking Threshold 245
└ Signal Track Trace 245

Center frequency
Defines the normal center frequency of the signal.

The allowed range of values for the center frequency depends on the frequency span.

span > 0: $span_{min}/2 \leq f_{center} \leq f_{max} - span_{min}/2$

zero span: $0\ Hz \leq f_{center} \leq f_{max}$

f_{max} and $span_{min}$ depend on the instrument and are specified in the data sheet.

Remote command:
`[SENSe:]FREQuency:CENTer` on page 570

Span
Defines the frequency span. The center frequency is kept constant. The following range is allowed:

span = 0: 0 Hz

span >0:

$span_{min} \leq f_{span} \leq f_{max}$

f_{max} and $span_{min}$ are specified in the data sheet.

For more information see chapter 3.3.1.1, "Defining the Scope of the Measurement - Frequency Range", on page 238.

Remote command:
`[SENSe:]FREQuency:SPAN` on page 572

Start / Stop
Defines the start and stop frequencies. The following range of values is allowed:

$f_{min} \leq \mathbf{f_{start}} \leq f_{max} - span_{min}$

$f_{min} + span_{min} \leq \mathbf{f_{stop}} \leq f_{max}$

f_{min}, f_{max} and $span_{min}$ are specified in the data sheet.

Remote command:
`[SENSe:]FREQuency:STARt` on page 572
`[SENSe:]FREQuency:STOP` on page 573

Frequency Axis Scaling
Switches between linear and logarithmic scaling for the frequency axis.

By default, the frequency axis has linear scaling. Logarithmic scaling of the frequency axis, however, is common for measurements over large frequency ranges as it enhances the resolution of the lower frequencies. On the other hand, high frequencies get more crowded and become harder to distinguish.

For more information see chapter 3.3.1.4, "Coping with Large Frequency Ranges - Logarithmic Scaling", on page 239.

Remote command:
DISPlay[:WINDow<n>]:TRACe:X:SPACing on page 574

Full Span
Sets the span to the full frequency range of the R&S FSWP specified in the data sheet. This setting is useful for overview measurements.

Remote command:
[SENSe:]FREQuency:SPAN:FULL on page 572

Zero Span
Sets the span to 0 Hz (zero span). The x-axis becomes the time axis with the grid lines corresponding to 1/10 of the current sweep time ("SWT").

For details see chapter 2.2, "Basic Measurements", on page 17.

Remote command:
FREQ:SPAN 0Hz, see [SENSe:]FREQuency:SPAN on page 572

Last Span
Sets the span to the previous value. With this function you can switch between an overview measurement and a detailed measurement quickly.

Remote command:
[SENSe:]FREQuency:SPAN on page 572

Center Frequency Stepsize
Defines the step size by which the center frequency is increased or decreased when the arrow keys are pressed. When you use the rotary knob the center frequency changes in steps of only 1/10 of the "Center Frequency Stepsize".

The step size can be coupled to the span (span > 0) or the resolution bandwidth (span = 0), or it can be manually set to a fixed value.

For more details see chapter 3.3.1.2, "Stepping Through the Frequency Range - Center Frequency Stepsize", on page 238.

"0.1 * Span / RBW"
Sets the step size for the center frequency to 10 % of the span / RBW.
This is the default setting.

"0.5 * Span / RBW"
Sets the step size for the center frequency to 50 % of the span / RBW.

"X * Span / RBW"
Sets the step size for the center frequency to a manually defined factor of the span / RBW. The "X-Factor" defines the percentage of the span / RBW.
Values between 1 and 100 % in steps of 1 % are allowed. The default setting is 10 %.

"= Center"
Sets the step size to the value of the center frequency and removes the coupling of the step size to span or resolution bandwidth. The used value is indicated in the "Value" field.

"= Marker"
This setting is only available if a marker is active.
Sets the step size to the value of the current marker and removes the coupling of the step size to span or resolution bandwidth. The used value is indicated in the "Value" field.

"Manual"
Defines a fixed step size for the center frequency. Enter the step size in the "Value" field.

Remote command:
`[SENSe:]FREQuency:CENTer:STEP:LINK` on page 571
`[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor` on page 571
`[SENSe:]FREQuency:CENTer:STEP` on page 570

Frequency Offset
Shifts the displayed frequency range along the x-axis by the defined offset.

This parameter has no effect on the instrument's hardware, or on the captured data or on data processing. It is simply a manipulation of the final results in which absolute frequency values are displayed. Thus, the x-axis of a spectrum display is shifted by a constant offset if it shows absolute frequencies, but not if it shows frequencies relative to the signal's center frequency.

A frequency offset can be used to correct the display of a signal that is slightly distorted by the measurement setup, for example.

The allowed values range from -100 GHz to 100 GHz. The default setting is 0 Hz.

Remote command:
`[SENSe:]FREQuency:OFFSet` on page 571

Signal Tracking
Defines the settings for signal tracking. These settings are only available for spans > 0.

For more details see chapter 3.3.1.3, "Keeping the Center Frequency Stable - Signal Tracking", on page 239.

Signal Tracking State ← Signal Tracking
Activates or deactivates signal tracking. This function is only available for spans > 0.

If activated, after each sweep, the center frequency is set to the maximum level of the specified trace found within the searched bandwidth.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:STRack[:STATe]` on page 573

Tracking Bandwidth ← Signal Tracking
Defines the search bandwidth for signal tracking around the center frequency.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:STRack:BANDwidth` on page 574

Tracking Threshold ← Signal Tracking
Defines the threshold value for signal tracking. If the signal level does not pass the threshold, the center frequency is not changed.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:STRack:THReshold` on page 574

Signal Track Trace ← Signal Tracking
Defines the trace to be tracked.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:STRack:TRACe` on page 574

3.3.3 How To Define the Frequency Range

The following step-by-step instructions demonstrate how to configure the frequency and span settings. For details on individual functions and settings see chapter 3.3.2, "Frequency and Span Settings", on page 240.

The remote commands required to perform these tasks are described in chapter 5.7.2, "Defining the Frequency", on page 569.

To configure the frequency and span

Frequency and span settings can be configured via the "Frequency" dialog box. Signal tracking is configured in the "Signal Tracking" tab of this dialog box.

1. To display the "Frequency" dialog box, do one of the following:
   - Select "Frequency" from the "Overview".
   - Select the FREQ key and then the "Frequency Config" softkey.
   - Select the SPAN key and then the "Frequency Config" softkey.
2. Define the frequency range using one of the following methods:
   - Define the "Center frequency" and "Span".
   - Define the "Start frequency" and "Stop frequency".
   - To perform a measurement in the time domain, define the "Center frequency" and select the "Zero span" button.
   - To perform a measurement over the entire available frequency range, select the "Full span" button.
   - To return to the previously set frequency range, select the "Last span" button.

3.3.4 How to Move the Center Frequency through the Frequency Range

In some cases it may be useful to move the center frequency through a larger frequency range, for example from one harmonic to another.

1. In the "Frequency" dialog box, define the "Center Frequency Stepsize". This is the size by which the center frequency is to be increased or decreased in each step. Enter a manual or relative value, or set the step size to the current center frequency or marker value. To move from one harmonic to the next, use the center frequency or marker value.
2. Select the "Center Frequency" dialog field.
3. Use the arrow keys to move the center frequency in discrete steps through the available frequency range.

3.3.5 How to Keep the Center Frequency Stable

If the signal is slightly instable on the display but you want to keep the center frequency on the signal peak, the center frequency can be adjusted automatically using **signal tracking**.

1. In the "Frequency" dialog box, select the "Signal Tracking" tab.
2. Define the following settings:
   - "Signal Tracking Bandwidth": the frequency range around the center frequency to be tracked
   - "Signal Tracking Threshold": the minimum level the trace must reach to be detected as a maximum
   - "Signal Tracking Trace": the trace to be tracked
3. Activate signal tracking by selecting "State: ON".

   After each sweep, the center frequency is set to the maximum signal found within the searched bandwidth. If no maximum signal above the defined threshold value is found in the searched bandwidth, the center frequency remains unchanged. The search bandwidth and the threshold value are shown in the diagram by red lines which are labeled as "TRK".

3.4 Amplitude and Vertical Axis Configuration

In the Spectrum application, measurement results usually consist of the measured signal levels (amplitudes) displayed on the vertical (y-)axis for the determined frequency spectrum or for the measurement time (horizontal, x-axis). The settings for the vertical axis, regarding amplitude and scaling, are described here.

- Impact of the Vertical Axis Settings....247
- Amplitude Settings....249
- Scaling the Y-Axis....253
- How to Optimize the Amplitude Display....254

3.4.1 Impact of the Vertical Axis Settings

Some background knowledge on the impact of the described settings is provided here for a better understanding of the required configuration.

- Reference Level....247
- RF Attenuation....248
- Scaling....249

3.4.1.1 Reference Level

The reference level value is the maximum value the AD converter can handle without distortion of the measured value. Signal levels above this value will not be measured correctly, which is indicated by the "IF OVLD" status display.

Internally, the reference level is also used to determine the optimum hardware settings for the R&S FSWP. The defined reference level should correspond with the maximum expected RF input level.

When determining the expected input level, consider that the power from *all* input signals contribute to the total power. The reference level must be higher than the total power from all signals.

The optimum reference level for the current measurement settings can be set automatically by the R&S FSWP (see "Reference Level" on page 250).

The reference level determines the amplitude represented by the topmost grid line in the display. When you change the reference level, the measurement is not restarted; the results are merely shifted in the display. Only if the reference level changes due to a coupled RF attenuation (see "Attenuation Mode / Value" on page 251), the measurement is restarted.

In general, the R&S FSWP measures the signal voltage at the RF input. The level display is calibrated in RMS values of an unmodulated sine wave signal. In the default state, the level is displayed at a power of 1 mW (= dBm). Via the known input impedance (50 Ω or 75 Ω, see "Impedance" on page 197), conversion to other units is possible.

Reference level offset

If the signal is attenuated or amplified before it is fed into the R&S FSWP, you can define an (arithmetic) offset to the reference level so the application shows correct power results. All displayed power level results are shifted by this value, and the scaling of the y-axis is changed accordingly.

To determine the required offset, consider the external attenuation or gain applied to the input signal. For attenuation, define a positive offset so the R&S FSWP increases the displayed power values.

If an external gain is applied, define a negative offset so the R&S FSWP decreases the displayed power values.

Note, however, that the *internal* reference level (used to adjust the hardware settings to the expected signal optimally) ignores any "Reference Level Offset". Thus, it is important to keep in mind the actual power level the R&S FSWP must handle, and not to rely on the displayed reference level.

internal reference level = displayed reference level - offset

Example

1. The initial reference level is 2 dBm with no offset.

   Both the displayed reference level and the internal reference level are 2 dBm.

2. An offset of 3 dB is defined.

   The displayed reference level is adjusted to 5 dBm.
   The internal reference level remains at 2 dBm.
   (5 dBm (displayed ref level) - 3 dB (offset) = 2 dBm)

3. Now the user decreases the reference level to 1 dBm.

   The displayed reference level is adjusted to 1 dBm.
   The internal reference level is adjusted to:
   1 dBm (displayed ref level) - 3 dB (offset) = -2 dBm.

3.4.1.2 RF Attenuation

The attenuation is meant to protect the input mixer from high RF input levels. The level at the input mixer is determined by the set RF attenuation according to the formula:

"$level_{mixer} = level_{input}$ – RF attenuation"

The maximum mixer level allowed is 0 dBm. Mixer levels above this value may lead to incorrect measurement results, which is indicated by the "RF OVLD" status display. Furthermore, higher input levels may damage the instrument. Therefore, the required RF attenuation is determined automatically according to the reference level by default.

High attenuation levels also avoid intermodulation. On the other hand, attenuation must be compensated for by re-amplifying the signal levels after the mixer. Thus, high attenuation values cause the inherent noise (i.e the noise floor) to rise and the sensitivity of the analyzer decreases.

The sensitivity of a signal analyzer is directly influenced by the selected RF attenuation. The highest sensitivity is obtained at an RF attenuation of 0 dB. Each additional 10 dB step reduces the sensitivity by 10 dB, i.e. the displayed noise is increased by 10 dB. To measure a signal with an improved signal-to-noise ratio, decrease the RF attenuation.

For ideal sinusoidal signals, the displayed signal level is independent of the RF attenuation.

Depending on the type of measurement evaluation that is required, a compromise must be found between a low noise floor and high intermodulation levels, and protecting the instrument from high input levels. This is best done by letting the R&S FSWP determine the optimum level automatically (see "Attenuation Mode / Value" on page 251).

3.4.1.3 Scaling

In a linear display, the measurement values are distributed linearly throughout the grid. That means the entire range of measured values is divided by the number of rows in the grid (10) and each row corresponds to 1/10 of the total range. Linear scaling is useful to determine precise levels for a small range of values. However, if large and small values appear in the same display, it is difficult to determine individual values precisely or to distinguish values that are close together.

In a logarithmic display, smaller values are distributed among a much larger area of the display, while large values are condensed to a smaller area. Now it is much easier to distinguish several lower values, as they are spread over a wider area. Logarithmic scaling is useful when large ranges of values must be combined in one display. Logarithmic scaling is best applied to measurement values in logarithmic units (dB, dBm etc.).

In addition to linear or logarithmic scaling, the vertical axis can be set to display either absolute or relative values. Absolute values show the measured levels, while relative values show the difference between the measured level and the defined reference level. Relative values are indicated in percent for linear scaling, and in dB for logarithmic scaling.

3.4.2 Amplitude Settings

Amplitude settings determine how the R&S FSWP must process or display the expected input power levels.

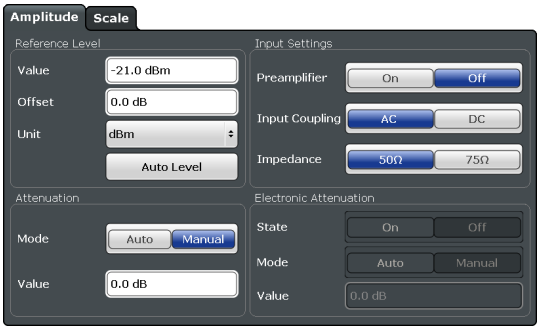
The dialog box also contain settings to scale the diagrams, which are described in chapter 3.4.3, "Scaling the Y-Axis", on page 253.

To configure the amplitude settings

Amplitude settings can be configured via the AMPT key or in the "Amplitude" dialog box.

► To display the "Amplitude" dialog box, do one of the following:

- Select "Amplitude" from the "Overview".
- Select "Input/Frontend" from the "Overview" and then switch to the "Amplitude" tab.
- Select the AMPT key and then the "Amplitude Config" softkey.



The remote commands required to define these settings are described in chapter 5.7.3, "Amplitude Settings", on page 575.

Functions in the "Amplitude" dialog box described elsewhere:

- "Input Coupling" on page 197
- "Impedance" on page 197

Reference Level....250
└ Shifting the Display (Offset)....250
└ Unit....251
└ Setting the Reference Level Automatically (Auto Level)....251
RF Attenuation....251
└ Attenuation Mode / Value....251
Preamplifier....252
Noise cancellation....252

Reference Level
Defines the expected maximum reference level. Signal levels above this value may not be measured correctly. This is indicated by an "IF OVLD" status display.

The reference level is also used to scale power diagrams; the reference level is then used as the maximum on the y-axis.

Since the hardware of the R&S FSWP is adapted according to this value, it is recommended that you set the reference level close above the expected maximum signal level to ensure an optimum measurement (no compression, good signal-to-noise ratio).

For details see chapter 3.4.1.1, "Reference Level", on page 247.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 576

Shifting the Display (Offset) ← Reference Level
Defines an arithmetic level offset. This offset is added to the measured level. In some result displays, the scaling of the y-axis is changed accordingly.

Define an offset if the signal is attenuated or amplified before it is fed into the R&S FSWP so the application shows correct power results. All displayed power level results will be shifted by this value.

The setting range is ±200 dB in 0.01 dB steps.

Note, however, that the *internal* reference level (used to adjust the hardware settings to the expected signal optimally) ignores any "Reference Level Offset". Thus, it is important to keep in mind the actual power level the R&S FSWP must handle, and not to rely on the displayed reference level (internal reference level = displayed reference level - offset).

For details see "Reference level offset" on page 247.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 576

Unit ← Reference Level
The R&S FSWP measures the signal voltage at the RF input.

In the default state, the level is displayed at a power of 1 mW (= dBm). Via the known input impedance (50 Ω or 75 Ω, see "Impedance" on page 197), conversion to other units is possible.

The following units are available and directly convertible:
- dBm
- dBmV
- dBµV
- dBµA
- dBpW
- Volt
- Ampere
- Watt

Remote command:
`INPut:IMPedance` on page 546
`CALCulate<n>:UNIT:POWer` on page 576

Setting the Reference Level Automatically (Auto Level) ← Reference Level
Automatically determines the optimal reference level for the current input data. At the same time, the internal attenuators are adjusted so the signal-to-noise ratio is optimized, while signal compression, clipping and overload conditions are minimized.

To determine the optimal reference level, a level measurement is performed on the R&S FSWP.

You can change the measurement time for the level measurement if necessary (see "Changing the Automatic Measurement Time (Meastime Manual)" on page 290).

Remote command:
`[SENSe:]ADJust:LEVel` on page 599

RF Attenuation
Defines the attenuation applied to the RF input of the R&S FSWP.

Attenuation Mode / Value ← RF Attenuation
The RF attenuation can be set automatically as a function of the selected reference level (Auto mode). This ensures that the optimum RF attenuation is always used. It is the default setting.

In "Manual" mode, you can set the RF attenuation in 1 dB steps (down to 0 dB). Other entries are rounded to the next integer value. The range is specified in the data sheet. If the defined reference level cannot be set for the defined RF attenuation, the reference level is adjusted accordingly and the warning "Limit reached" is displayed.

NOTICE! Risk of hardware damage due to high power levels. When decreasing the attenuation manually, ensure that the power level does not exceed the maximum level allowed at the RF input, as an overload may lead to hardware damage.

For details see chapter 3.4.1.2, "RF Attenuation", on page 248.

Remote command:
`INPut:ATTenuation` on page 577
`INPut:ATTenuation:AUTO` on page 577

Preamplifier
If the (optional) Preamplifier hardware is installed, a preamplifier can be activated for the RF input signal.

You can use a preamplifier to analyze signals from DUTs with low input power.

For R&S FSWP26 or higher models, the input signal is amplified by 30 dB if the preamplifier is activated.

For R&S FSWP8, the following settings are available:

"Off" Deactivates the preamplifier.

"15 dB" The RF input signal is amplified by about 15 dB.

"30 dB" The RF input signal is amplified by about 30 dB.

Remote command:
`INPut:GAIN:STATe` on page 578
`INPut:GAIN[:VALue]` on page 577

Noise cancellation
The results can be corrected by the instrument's inherent noise, which increases the dynamic range.

In this case, a reference measurement of the instrument's inherent noise is carried out. The measured noise power is then subtracted from the power in the channel that is being analyzed (first active trace only).

The inherent noise of the instrument depends on the selected center frequency, resolution bandwidth and level setting. Therefore, the correction function is disabled whenever one of these parameters is changed. A disable message is displayed on the screen. To enable the correction function after changing one of these settings, activate it again. A new reference measurement is carried out.

Noise cancellation is also available in zero span.

Currently, noise cancellation is only available for the following trace detectors:

- RMS
- Average
- Sample
- Positive Peak

Remote command:
`[SENSe:]POWer:NCORrection` on page 575

3.4.3 Scaling the Y-Axis

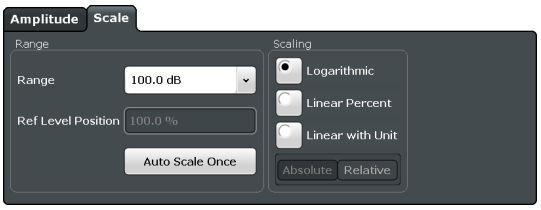
The individual scaling settings that affect the vertical axis are described here.

To configure the y-axis scaling settings

Vertical Axis settings can be configured via the AMPT key or in the "Amplitude" dialog box.

► To display the "Amplitude" dialog box, do one of the following:

- Select "Amplitude" from the "Overview".
- Select the AMPT key and then the "Scale Config" softkey.



The remote commands required to define these settings are described in chapter 5.7.4, "Scaling the Y-Axis", on page 578.

Range....253
Ref Level Position....253
Auto Scale Once....253
Scaling....254

Range
Defines the displayed y-axis range in dB.

The default value is 100 dB.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 578

Ref Level Position
Defines the reference level position, i.e. the position of the maximum AD converter value on the level axis in %, where 0 % corresponds to the lower and 100 % to the upper limit of the diagram.

For spectrograms, this value defines the position of the reference level value within the span covered by the color map. In this case, the value is given in %, where 0 % corresponds to the maximum (right end) and 100 % to the minimum (left end) of the color map.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 579

Auto Scale Once
Automatically determines the optimal range and reference level position to be displayed for the current measurement settings.

The display is only set once; it is not adapted further if the measurement settings are changed again.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE` on page 578

Scaling
Defines the scaling method for the y-axis.

For more information see chapter 3.4.1.3, "Scaling", on page 249.

"Logarithmic"	Logarithmic scaling (only available for logarithmic units - dB..., and A, V, Watt)
"Linear Unit"	Linear scaling in the unit of the measured signal
"Linear Percent"	Linear scaling in percentages from 0 to 100
"Absolute"	The labeling of the level lines refers to the absolute value of the reference level (not available for "Linear Percent")
"Relative"	The scaling is in dB, relative to the reference level (only available for logarithmic units - dB...). The upper line of the grid (reference level) is always at 0 dB.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing` on page 580
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE` on page 579

3.4.4 How to Optimize the Amplitude Display

This section gives you some advice on how to optimize the display of the measured signal amplitudes depending on the required evaluation.

1. Perform a measurement with the default settings to get an impression of the values to be expected.
2. Use the "Auto Level" function (AUTO menu) to optimize the reference level.
3. Use the "Auto Scale" function (AUTO menu) to optimize the scaling.
4. **To determine a precise level at a specific point in the signal:**
   - Reduce the "Range" of the y-axis to a small area around the required level. If necessary, change the "Ref Level Position" so the required range remains visible.
   - Select "Linear Unit" scaling.

   Now you can set a marker at the point in question and read the result.
5. **To detect a spurious signal close to the noise floor:**
   - Set the "RF attenuation" to "Manual" mode and reduce the "Value" to lower the noise floor.
   - Select "Relative - Logarithmic" scaling.

Now you can determine if any spurious levels of a certain size are visible.

3.5 Bandwidth, Filter and Sweep Configuration

The basic bandwidth, filter and sweep settings that apply to most measurements are described here. These parameters define how the data is measured: how much data is collected internally and which filters are used.

- Impact of the Bandwidth, Filter and Sweep Settings....255
- Bandwidth, Filter and Sweep Settings....261
- Reference: List of Available RRC and Channel Filters....269

3.5.1 Impact of the Bandwidth, Filter and Sweep Settings

The bandwidth, filter and sweep settings are closely related and interdependant. The values available for resolution bandwidth and video bandwidth depend on the selected filter type. In addition, these settings have an impact on other measurement parameters. The following equation shows the interdependency of these settings:

$$T_{sweepMIN} = K*Span/RBW^2$$

where K = Filter constant

By default, a Gaussian filter is used. The resolution bandwidth, the video bandwidth and the sweep time are set automatically according to the set span, and default coupling is used. Thus, the following settings are applied:

RBW = 100 * Span

VBW = RBW = 100 * Span

Sweep time = T_{min} for set Span, RBW, VBW

When defining the bandwidth and filter settings, consider the impact of the individual settings on the other settings and the measurement result, as described in more detail in the following sections.

- Separating Signals by Selecting an Appropriate Resolution Bandwidth....256
- Smoothing the Trace Using the Video Bandwidth....256
- Coupling VBW and RBW....257
- Coupling Span and RBW....257
- How Data is Measured: the Sweep Type....258
- Which Data May Pass: Filter Types....259
- How Long the Data is Measured: Sweep Time....259
- How Much Data is Measured: Sweep Points and Sweep Count....260
- How Often Data is Measured: Sweep Mode....260

3.5.1.1 Separating Signals by Selecting an Appropriate Resolution Bandwidth

The resolution bandwidth defines the 3 dB bandwidth of the resolution filter to be used. An RF sinusoidal signal is displayed according to the passband characteristic of the resolution filter (RBW), i.e. the signal display reflects the shape of the filter.

A basic feature of a signal analyzer is being able to separate the spectral components of a mixture of signals. The resolution at which the individual components can be separated is determined by the resolution bandwidth. Selecting a resolution bandwidth that is too large may make it impossible to distinguish between spectral components, i.e. they are displayed as a single component. Smaller resolution bandwidths, however, increase the required measurement time.

Two signals with the same amplitude can be resolved if the resolution bandwidth is smaller than or equal to the frequency spacing of the signal. If the resolution bandwidth is equal to the frequency spacing, the spectrum display screen shows a level drop of 3 dB precisely in the center of the two signals. Decreasing the resolution bandwidth makes the level drop larger, which thus makes the individual signals clearer.

The highest sensitivity is obtained at the smallest bandwidth (1 Hz). If the bandwidth is increased, the reduction in sensitivity is proportional to the change in bandwidth. Increasing the bandwidth by a factor of 3 increases the displayed noise by approx. 5 dB (4.77 dB precisely). If the bandwidth is increased by a factor of 10, the displayed noise increases by a factor of 10, i.e. 10 dB.

If there are large level differences between signals, the resolution is determined by selectivity as well as by the resolution bandwidth that has been selected. The measure of selectivity used for signal analyzers is the ratio of the 60 dB bandwidth to the 3 dB bandwidth (= shape factor).

For the R&S FSWP, the shape factor for bandwidths is < 5, i.e. the 60 dB bandwidth of the 30 kHz filter is <150 kHz.

The higher spectral resolution with smaller bandwidths is won by longer sweep times for the same span. The sweep time has to allow the resolution filters to settle during a sweep at all signal levels and frequencies to be displayed.

If the RBW is too large, signal parts that are very far away (e.g. from a different signal) are considered in the measurement and distort the results. The noise increases.

If the RBW is too small, parts of the signal are lost. As the displayed signal always reflects the shape of the filter, select a bandwidth large enough so the displayed signal reflects the entire shape of the filter.

3.5.1.2 Smoothing the Trace Using the Video Bandwidth

The video filters are responsible for smoothing the displayed trace. Using video bandwidths that are small compared to the resolution bandwidth, only the signal average is displayed and noise peaks and pulsed signals are repressed. If pulsed signals are to be measured, it is advisable to use a video bandwidth that is large compared to the resolution bandwidth (VBW = 10 x RBW) for the amplitudes of pulses to be measured correctly.

The level of a sine wave signal is not influenced by the video bandwidth. A sine wave signal can therefore be freed from noise by using a video bandwidth that is small compared with the resolution bandwidth, and thus be measured more accurately.

RMS/Average detector and VBW

If an RMS or average detector is used, the video bandwidth in the hardware is bypassed. Thus, duplicate trace averaging with small VBWs and RMS or average detector no longer occurs. However, the VBW is still considered when calculating the sweep time. This leads to a longer sweep time for small VBW values. Thus, you can reduce the VBW value to achieve more stable trace curves even when using an RMS or average detector. Normally, if the RMS or average detector is used the sweep time should be increased to get more stable traces.

3.5.1.3 Coupling VBW and RBW

The video bandwidth can be coupled to the resolution bandwidth automatically. In this case, if the resolution bandwidth is changed, the video bandwidth is automatically adjusted.

Coupling is recommended if a minimum sweep time is required for a selected resolution bandwidth. Narrow video bandwidths require longer sweep times due to the longer settling time. Wide bandwidths reduce the signal/noise ratio.

Table 3-1: Overview of RBW/VBW ratios and recommendations for use

Ratio RBW/VBW	Recommendation for use
1/1	Recommended for sinusoidal signals This is the default setting for automatic coupling.
0.1	Recommended when the amplitudes of pulsed signals are to be measured correctly. The IF filter is exclusively responsible for the pulse shape. No additional evaluation is performed by the video filter.
10	Recommended to suppress noise and pulsed signals in the video domain.
Manually set (0.001 to 1000)	Recommended for other measurement requirements

3.5.1.4 Coupling Span and RBW

The resolution bandwidth can be coupled to the span setting, either by a manually defined factor or automatically. If the span is changed, the resolution bandwidth is automatically adjusted. The automatic coupling adapts the resolution bandwidth to the currently set frequency span/100.

With a span/RBW ratio of 100 and a screen resolution of 1000 pixels, each frequency in the spectrum is displayed by 10 pixels. A span/RBW ratio of 1000 provides the highest resolution.

A higher span/RBW ratio (i.e. low RBW values and large frequency spans), however, results in large amounts of data.

3.5.1.5 How Data is Measured: the Sweep Type

In a standard analog **frequency sweep**, the local oscillator of the analyzer sweeps the applied signal quasi analog from the start to the stop frequency to determine the frequency spectrum.

Alternatively, the analyzer can sample signal levels over time at a defined frequency and transform the data to a spectrum by Fast Fourier Transformation (**FFT**). Although this measurement method requires additional calculations, it can provide results much faster than the frequency sweep, in particular for small RBWs.

Which sweep mode is appropriate for the current measurement depends on the span, RBW, VBW and sweep time settings. By default ("Auto" sweep type), the R&S FSWP automatically uses the sweep type with the highest sweep rate depending on these measurement settings.

Restrictions for FFT mode

FFT mode is not available when using 5-Pole filters, Channel filters or RRC filters, or the Quasi peak detector. In this case, sweep mode is used.

The same applies when an external generator is active (with the optional External Generator Control).

Optimization

In FFT mode, FFT analysis is performed to determine a spectrum of frequencies. Several analysis steps are required to cover the entire span. The partial span which is covered by one FFT analysis depends on the RBW. The partial span cannot be defined directly, but it can be optimized according to measurement requirements.

Narrow partial spans provide a higher dynamic range, and also allow you to perform measurements near a carrier with a reduced reference level. With a wide partial span, the carrier and the useful signal are likely to be measured at the same time, in which case the powers of both signals are summarized, so the reference level must be high enough to consider this factor. With a narrow partial span, this is less likely to happen, so the reference level can be reduced.

For an optimal dynamic range, the narrowest possible partial span (depending on the RBW) is used. Furthermore, the autorange function for the internal IF gain calculation is activated to obtain the best control range of the A/D converter.

On the other hand, the narrower the partial span, the more steps are required to cover the entire span, thus increasing analysis and calculation time. To **optimize the sweep rate**, the widest possible partial span (depending on the RBW) is used.

For an optimal sweep rate, it is recommended that you set the sweep time to "Auto", as well.

For general purpose measurements, an "Auto" mode is available, which provides a **compromise between a large dynamic range and a fast sweep**. In this case, a medium-sized partial span is used.

Optimization for zero span sweeps

For normal sweeps in the time domain (zero span), the optimization mode determines the selection of the A/D converter prefilter, which depends on the RBW.

In **"Dynamic" mode**, the narrowest possible prefilter is used.

In **"Speed" mode**, the widest possible prefilter is used.

In **"Auto" mode**, a medium-sized prefilter is used.

3.5.1.6 Which Data May Pass: Filter Types

While the filter is irrelevant when measuring individual narrowband signals (as long as the signal remains within the RBW), the measurement result for broadband signals is very dependant on the selected filter type and its shape. If the filter is too narrow, the signal is distorted by the filter. If the filter is too wide, multiple signals can no longer be distinguished. Generally, the smaller the filter width and the steeper its edges, the longer the settling time and thus the longer the sweep time must be.

All resolution bandwidths are realized with digital filters. Normal (3dB) Gaussian filters are set by default. Some communication standards require different filters.

For a list of available filter types, see chapter 3.5.3, "Reference: List of Available RRC and Channel Filters", on page 269.

Normal (3 dB) Gaussian filters

Gaussian filters provide a good compromise between steep edges and a short settling time. This filter is suitable for most measurement tasks and is used by default.

The available Gaussian (3 dB) sweep filters are listed in the R&S FSWP data sheet.

Channel filters

Channel filters are fairly steep but require a long settling time; they are useful for pulse measurements in the time domain.

RRC filters

Root raised cosine filters are similar in shape to channel filters and are required by some measurement standards.

5-Pole filters

5-Pole filters are very broad and allow for a large bandwidth to pass.

3.5.1.7 How Long the Data is Measured: Sweep Time

Each filter has a settling time that must be awaited in order to obtain correct results. Since the resolution bandwidth and video bandwidth define the filter, the smaller of the two determines the minimum sweep time required for the measurement. Allowed values depend on the ratio of span to RBW and RBW to VBW.

If the selected sweep time is too short for the selected bandwidth and span, level measurement errors will occur. In this case, the R&S FSWP displays the error message "Sweep time too low" and marks the indicated sweep time with a red bullet. Furthermore, a status bit indicates an error.

The sweep time can be coupled to the span (not zero span), video bandwidth (VBW) and resolution bandwidth (RBW) automatically. If the span, resolution bandwidth or video bandwidth is changed, the sweep time is automatically adjusted.

Note that the sweep time only indicates how long data is captured; the time required to process the captured data may be considerably longer, in particular for FFT sweeps. For FFT sweeps, an estimated duration is indicated behind the sweep time in the channel bar (in the Spectrum application only).

3.5.1.8 How Much Data is Measured: Sweep Points and Sweep Count

By default, 1001 data points are determined in a single sweep. During the next sweep, 1001 new data points are collected, and so on. The number of **sweep points** defines how much of the entire span is covered by a single data point. By increasing the number of sweep points you can increase the reliability of the individual data points and thus the accuracy of the analyzed results. However, these data points are all stored on the instrument, occupying a large amount of memory, and each sweep point increases the overall measurement time. Up to 200 000 points can be swept at once.

The number of sweeps to be performed in single sweep mode is defined by the "Sweep Count". Values from 0 to 200000 are allowed. If the values 0 or 1 are set, one sweep is performed. The sweep count is applied to all the traces in a diagram.

If the trace configurations "Average", "Max Hold" or "Min Hold" are set, the "sweep/average count" also determines the number of averaging or maximum search procedures (see chapter 4.3.1.2, "Analyzing Several Traces - Trace Mode", on page 316).

For details on how the number of sweep points and the sweep count affect the trace results on the screen, see chapter 4.3.1.1, "Mapping Samples to measurement Points with the Trace Detector", on page 313.

3.5.1.9 How Often Data is Measured: Sweep Mode

How often the spectrum is swept depends on the sweep mode. Either a certain number of sweeps can be defined ("Sweep Count") which are performed in "Single Sweep" mode, or the sweep is repeated continuously ("Continuous Sweep" mode).

By default, the data is collected for the specified number of sweeps and the corresponding trace is displayed. When the next sweep is started, the previous trace is deleted.

However, the data from a single sweep run can also be retained and displayed together with the new data ("Continue Single Sweep" mode). This is particularly of interest when using the trace configurations "Average" or "Max Hold" to take previously recorded measurements into account for averaging/maximum search (see chapter 4.3.1.2, "Analyzing Several Traces - Trace Mode", on page 316).

3.5.2 Bandwidth, Filter and Sweep Settings

To configure the bandwidth, filter and sweep

Bandwidth and filter settings can be configured via the "Bandwidth" tab of the "Bandwidth" dialog box.

Sweep settings can be configured in the Sweep dialog box or via the "Sweep" tab of the "Bandwidth" dialog box.

1. To display the "Bandwidth" dialog box, do one of the following:
   - Select "Bandwidth" from the "Overview".
   - Select the BW key and then the "Bandwidth Config" softkey.
   - Select the SWEEP key and then the "Sweep Config" softkey.
2. To display the "Sweep" dialog box, do one of the following:
   - Select "Bandwidth" from the "Overview" and switch to the "Sweep" tab in the "Bandwidth" dialog box.
   - Select the SWEEP key and then the "Sweep Config" softkey.

The remote commands required to define these settings are described in chapter 5.7.5, "Remote Commands to Define Filter Characteristics", on page 580.

How to perform a basic sweep measurement is described in chapter 2.2.1, "How to Perform a Basic Sweep Measurement", on page 17.

Fig. 3-17: Bandwidth dialog box

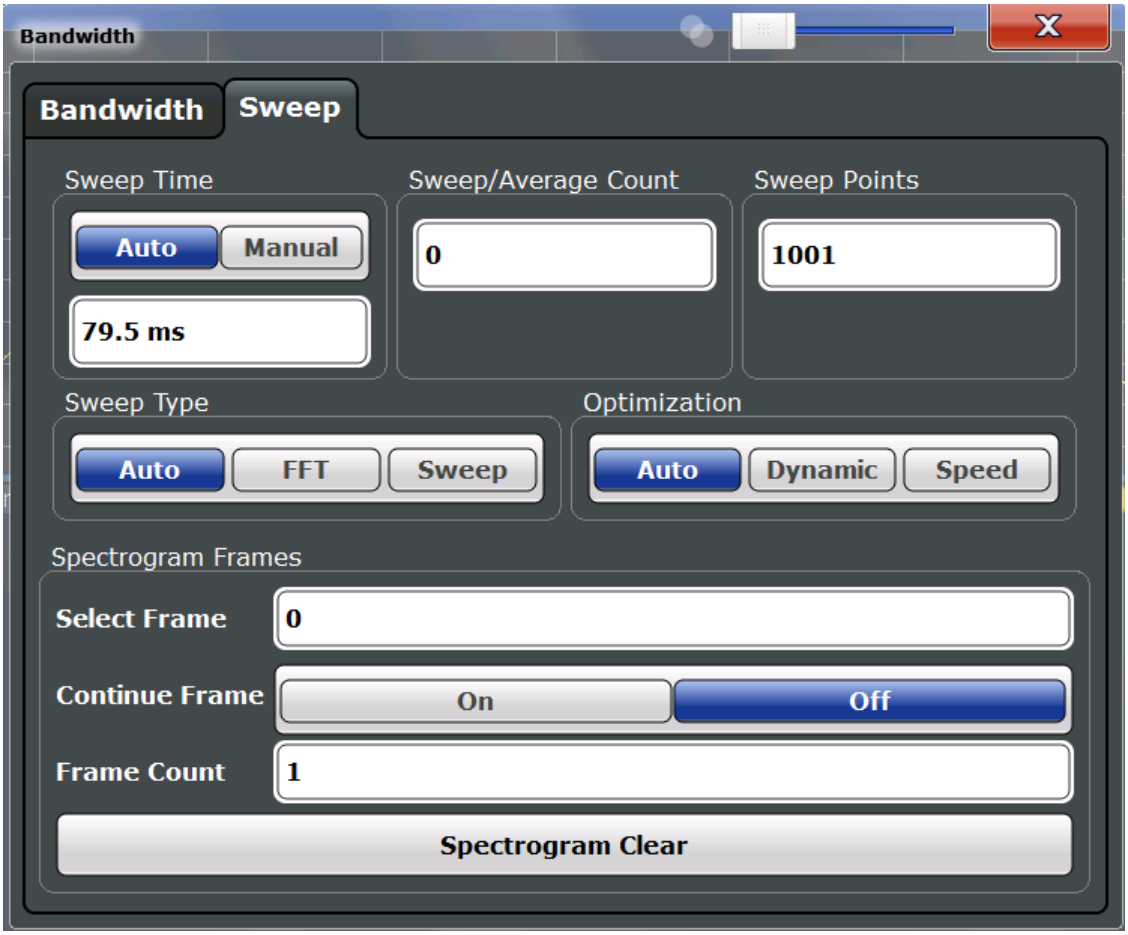


Fig. 3-18: Sweep dialog box for spectrogram display

RBW....263
VBW....263
Sweep Time....263
Span/RBW....264
RBW/VBW....264
Filter Type....264
Default Coupling....265
Sweep / Average Count....265
Sweep Points....265
Optimization....266
Sweep Type....266
Single Sweep/ RUN SINGLE....267
Continuous Sweep/RUN CONT....267
Continue Single Sweep....268
Spectrogram Frames....268
└ Selecting a frame to display....268
└ Continue Frame....268
└ Frame Count....269
└ Clear Spectrogram....269

RBW
Defines the resolution bandwidth. The available resolution bandwidths are specified in the data sheet. Numeric input is always rounded to the nearest possible bandwidth.

If "AUTO" is selected, the resolution bandwidth is coupled to the selected span (for span > 0). If the span is changed, the resolution bandwidth is automatically adjusted.

If the resolution bandwidth is defined manually, a green bullet is displayed next to the "RBW" display in the channel bar.

For more information see chapter 3.5.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth", on page 256.

For measurements on I/Q data in the frequency domain, the maximum RBW is 1 MHz.

Remote command:
`[SENSe:]BANDwidth[:RESolution]` on page 581
`[SENSe:]BANDwidth[:RESolution]:AUTO` on page 581

VBW
Defines the video bandwidth automatically or manually.

For more information see chapter 3.5.1.2, "Smoothing the Trace Using the Video Bandwidth", on page 256.

"Auto" The video bandwidth is coupled to the resolution bandwidth. If the resolution bandwidth is changed, the video bandwidth is automatically adjusted.

"Manual" For manual mode, define the bandwidth value. The available video bandwidths are specified in the data sheet. Numeric input is always rounded to the nearest possible bandwidth.
If the video bandwidth is defined manually, a green bullet is displayed next to the "VBW" display in the channel bar.

Remote command:
`[SENSe:]BANDwidth:VIDeo:AUTO` on page 582
`[SENSe:]BANDwidth:VIDeo` on page 582

Sweep Time
Defines the duration of a single sweep, during which the defined number of sweep points are measured. The sweep time can be defined automatically or manually.

The allowed sweep times depend on the device model; refer to the data sheet.

For more information see chapter 3.5.1.7, "How Long the Data is Measured: Sweep Time", on page 259.

Note: The sweep time only indicates how long data is captured; the time required to process the captured data may be considerably longer, in particular for FFT sweeps. For FFT sweeps, an estimated duration is indicated behind the sweep time in the channel bar (in the Spectrum application only).

"Auto" The sweep time is coupled to the span (not zero span), video bandwidth (VBW) and resolution bandwidth (RBW). If the span, resolution bandwidth or video bandwidth is changed, the sweep time is automatically adjusted.

"Manual" For manual mode, define the sweep time. Allowed values depend on the ratio of span to RBW and RBW to VBW. For details refer to the data sheet. Numeric input is always rounded to the nearest possible sweep time.

Remote command:
`[SENSe:]SWEep:TIME:AUTO` on page 588

Span/RBW
Sets the coupling ratio if RBW is set to auto mode.

For more information see chapter 3.5.1.4, "Coupling Span and RBW", on page 257.

"Auto [100]" "resolution bandwidth = span/100"
This coupling ratio is the default setting of the R&S FSWP.

"Manual" The coupling ratio is defined manually.
The span/resolution bandwidth ratio can be set in the range from 1 to 10000.

Remote command:
`[SENSe:]BANDwidth[:RESolution]:RATio` on page 581

RBW/VBW
Sets the coupling ratio between the resolution bandwidth and the video bandwidth.

This setting is only effective if VBW is set to auto mode.

For more information see chapter 3.5.1.3, "Coupling VBW and RBW", on page 257.

"Sine [1/1]" "video bandwidth = resolution bandwidth"
This is the default setting for the coupling ratio RBW/VBW and is recommended if sinusoidal signals are to be measured.

"Pulse [.1]" "video bandwidth = 10 × resolution bandwidth"
or
"video bandwidth = 10 MHz (= max. VBW)"
Recommended for pulse signals

"Noise [10]" "video bandwidth = resolution bandwidth/10"
Recommended for noise measurements

"Manual" The coupling ratio is defined manually.
The RBW/VBW ratio can be set in the range of 0.001 to 1000.

Remote command:
`[SENSe:]BANDwidth:VIDeo:AUTO` on page 582
`[SENSe:]BANDwidth:VIDeo:RATio` on page 583

Filter Type
Defines the filter type.

The following filter types are available:

- Normal (3dB)
- Channel
- RRC
- 5-Pole (not available for sweep type "FFT")

For more information see chapter 3.5.1.6, "Which Data May Pass: Filter Types", on page 259.

Remote command:
[SENSe:]BANDwidth[:RESolution]:TYPE on page 582

Default Coupling
Sets all coupled functions to the default state ("AUTO"). In addition, the ratio "RBW/VBW" is set to "SINE [1/1]" and the ratio "SPAN/RBW" to *100.*

For more information see chapter 3.5.1.3, "Coupling VBW and RBW", on page 257.

Remote command:
[SENSe:]BANDwidth[:RESolution]:AUTO on page 581
[SENSe:]BANDwidth:VIDeo:AUTO on page 582
[SENSe:]SWEep:TIME:AUTO on page 588

Sweep / Average Count
Defines the number of measurements to be performed in the single sweep mode. Values from 0 to 200000 are allowed. If the values 0 or 1 are set, one measurement is performed.

The sweep count is applied to all the traces in all diagrams.

If the trace modes "Average", "Max Hold" or "Min Hold" are set, this value also determines the number of averaging or maximum search procedures.

In continuous sweep mode, if sweep count = 0 (default), averaging is performed over 10 measurements. For sweep count =1, no averaging, maxhold or minhold operations are performed.

For more information see chapter 3.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 260.

For spectrogram displays, the sweep count determines how many measurements are combined in one frame in the spectrogram, i.e. how many measurements the R&S FSWP performs to plot one trace in the spectrogram result display. For more details see "Time Frames" on page 321.

Remote command:
[SENSe:]SWEep:COUNt on page 585
[SENSe:]AVERage<n>:COUNt on page 584

Sweep Points
Defines the number of measured values to be collected during one sweep.

For details see chapter 3.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 260.

All values from 101 to 100001 can be set. The default value is 1001 sweep points.

Remote command:
[SENSe:]SWEep:POINts on page 587

Optimization

In FFT mode, several FFT analysis steps are required to cover the entire measurement span. The span which is covered by one FFT analysis step is called *partial span*. The partial span cannot be defined directly, but it can be optimized according to measurement requirements.

Table 3-2: Optimization parameters in FFT mode

Optimization mode	Description
Dynamic	Optimizes the dynamic range by using the narrowest possible partial span (depending on the RBW). The autorange function for the internal IF gain calculation is activated to obtain the best control range for the A/D converter.
Speed	Optimizes the sweep rate by using the widest possible partial span (depending on the RBW). The autorange function for the internal IF gain calculation is deactivated. (Note: set the reference level accordingly to optimize the control range for the A/D converter). It is recommended that you set the Sweep Time to "Auto" to optimize the sweep rate.
Auto	Uses a medium-sized partial span to obtain a compromise between a large dynamic range and a fast sweep rate. The autorange function for the internal IF gain calculation is activated to obtain the best control range for the A/D converter.

Zero span mode

For zero span measurements, the optimization mode defines the selection of the A/D converter prefilter.

Table 3-3: Optimization parameters in zero span mode

Optimization mode	Description
Dynamic	The narrowest filter possible (depending on the RBW) is used.
Speed	The widest filter possible (depending on the RBW) is used.
Auto	A medium-sized prefilter is used.

Remote command:
`[SENSe:]SWEep:OPTimize` on page 586

Sweep Type

Defines the sweep type.

"Sweep" In the standard sweep mode, the local oscillator is set to provide the spectrum quasi analog from the start to the stop frequency.

"Auto" Automatically sets the fastest available sweep type for the current measurement (Frequency or FFT). Auto mode is set by default.

"FFT" The FFT sweep samples on a defined frequency value and transforms it to the spectrum by fast Fourier transformation (FFT) (see also chapter 3.5.1.5, "How Data is Measured: the Sweep Type", on page 258).
FFT is not available in the following cases:

- when using 5-Pole filters, Channel filters or RRC filters
- when an external generator is active (via hardware option)

In these cases, frequency sweep is used.

Remote command:
`[SENSe:]SWEep:TYPE` on page 588

Single Sweep/ RUN SINGLE
After triggering, starts the number of sweeps set in "Sweep Count". The measurement stops after the defined number of sweeps has been performed.

While the measurement is running, the "Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in single sweep mode is swept only once by the Sequencer.
Furthermore, the RUN SINGLE key controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.

If the Sequencer is off, only the evaluation for the currently displayed measurement channel is updated.

For details on the Sequencer, see the R&S FSWP User Manual.

Remote command:
`INITiate<n>[:IMMediate]` on page 403
`CALCulate<n>:SPECtrogram:CONT` on page 617

Continuous Sweep/RUN CONT
After triggering, starts the sweep and repeats it continuously until stopped. This is the default setting.

While the measurement is running, the "Continuous Sweep" softkey and the RUN CONT key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again. The results are not deleted until a new measurement is started.

Note: Sequencer. If the Sequencer is active, the "Continuous Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly.
Furthermore, the RUN CONT key controls the Sequencer, not individual sweeps. RUN CONT starts the Sequencer in continuous mode.

For details on the Sequencer, see the R&S FSWP User Manual.

Remote command:
INITiate<n>:CONTinuous on page 404

Continue Single Sweep
After triggering, repeats the number of sweeps set in "Sweep Count", without deleting the trace of the last measurement.

While the measurement is running, the "Continue Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Remote command:
INITiate<n>:CONMeas on page 403

Spectrogram Frames
These settings are only available if spectrogram display is active.

For more information see chapter 4.3.5, "How to Display and Configure a Spectrogram", on page 339.

Selecting a frame to display ← Spectrogram Frames
Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Spectrum window.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

The most recent frame is number 0, all previous frames have a negative number.

For more details see "Time Frames" on page 321.

Remote command:
CALCulate<n>:SPECtrogram:FRAMe:SELect on page 618

Continue Frame ← Spectrogram Frames
Determines whether the results of the previous sweeps are included in the analysis of the next sweeps for trace modes "Max Hold", "Min Hold", and "Average".

This function is available in single sweep mode only.

- **On**
  When the average or peak values are determined for the new sweep, the results of the previous sweeps in the spectrogram are also taken into account.
- **Off**
  The average or peak values are determined from the results of the newly swept frames only.

Remote command:
CALCulate<n>:SPECtrogram:CONT on page 617

Frame Count ← Spectrogram Frames
Determines how many frames are plotted during a single sweep measurement (as opposed to a continuous sweep). The maximum number of possible frames depends on the history depth (see "History Depth" on page 334).

For more details see "Time Frames" on page 321.

Remote command:
CALCulate<n>:SPECtrogram:FRAMe:COUNt on page 617

Clear Spectrogram ← Spectrogram Frames
Resets the spectrogram result display and clears the history buffer.

This function is only available if a spectrogram is selected.

Remote command:
CALCulate<n>:SPECtrogram:CLEar[:IMMediate] on page 617

3.5.3 Reference: List of Available RRC and Channel Filters

For power measurement a number of especially steep-edged channel filters are available (see the following table). The indicated filter bandwidth is the 3 dB bandwidth. For RRC filters, the fixed roll-off factor (a) is also indicated.

The available Gaussian 3 dB sweep filters are listed in the R&S FSWP data sheet.

Table 3-4: Filter types

Filter Bandwidth	Filter Type	Application
100 Hz	CFILter	
200 Hz	CFILter	
300 Hz	CFILter	
500 Hz	CFILter	
1 kHz	CFILter	
1.5 kHz	CFILter	
2 kHz	CFILter	
2.4 kHz	CFILter	SSB
2.7 kHz	CFILter	
3 kHz	CFILter	
3.4 kHz	CFILter	
4 kHz	CFILter	DAB, Satellite
4.5 kHz	CFILter	

Filter Bandwidth	Filter Type	Application
5 kHz	CFILter	
6 kHz	CFILter	
6 kHz, a=0.2	RRC	APCO
8.5 kHz	CFILter	ETS300 113 (12.5 kHz channels)
9 kHz	CFILter	AM Radio
10 kHz	CFILter	
12.5 kHz	CFILter	CDMAone
14 kHz	CFILter	ETS300 113 (20 kHz channels)
15 kHz	CFILter	
16 kHz	CFILter	ETS300 113 (25 kHz channels)
18 kHz, a=0.35	RRC	TETRA
20 kHz	CFILter	
21 kHz	CFILter	PDC
24.3 kHz, a=0.35	RRC	IS 136
25 kHz	CFILter	APCO 25-P2
30 kHz	CFILter	CDPD, CDMAone
50 kHz	CFILter	
100 kHz	CFILter	
150 kHz	CFILter	FM Radio
192 kHz	CFILter	PHS
200 kHz	CFILter	GSM
300 kHz	CFILter	
500 kHz	CFILter	J.83 (8-VSB DVB, USA); RF ID 14333
1 MHz	CFILter	CDMAone
1.228 MHz	CFILter	CDMAone
1.28 MHz, a=0.22	RRC	TD-SCDMA
1.5 MHz	CFILter	DAB
2 MHz	CFILter	
3 MHz	CFILter	
3.75 MHz	CFILter	

Filter Bandwidth	Filter Type	Application
3.84 MHz, a=0.22	RRC	W-CDMA 3GPP
4.096 MHz, a=0.22	RRC	W-CDMA NTT DOCoMo
5 MHz	CFILter	
10 MHz *)	CFILter	
20 MHz *)	CFILter	
28 MHz *)	CFILter	
40 MHz *)	CFILter	
80 MHz *)	CFILter	
*) These filters are only available with option R&S FSWP-B8 (Resolution Bandwidths > 10 MHz). Filters larger than 10 MHz require an appropriate bandwidth extension option.		

3.6 Trigger and Gate Configuration

Triggering means to capture the interesting part of the signal. Choosing the right trigger type and configuring all trigger settings correctly allows you to detect various incidents in your signals.

Gating allows you to restrict measurement analysis to the important part or parts of the signal, for example bursts.

- Basics of Triggering and Gated Measurements....271
- Trigger and Gate Settings....277
- How to Configure a Triggered and Gated Measurement....285
- How to Output a Trigger Signal....288

3.6.1 Basics of Triggering and Gated Measurements

Some background knowledge on triggering and gated measurements is provided here for a better understanding of the required configuration settings.

- Triggered Measurements....271
- Gated Measurements....275
- Determining the Parameters in Preview Mode....277

3.6.1.1 Triggered Measurements

In a basic measurement with default settings, the measurement is started immediately. However, sometimes you want the measurement to start only when a specific condition is fulfilled, for example a signal level is exceeded, or in certain time intervals. For these cases you can define a trigger for the measurement. In FFT sweep mode, the trigger defines when the data acquisition starts for the FFT conversion.

An "Offset" can be defined to delay the measurement after the trigger event, or to include data before the actual trigger event in time domain measurements (pre-trigger offset).

For complex tasks, advanced trigger settings are available:

- Hysteresis to avoid unwanted trigger events caused by noise
- Holdoff to define exactly which trigger event will cause the trigger in a jittering signal

- Trigger Source 272
- Trigger Offset 272
- Trigger Hysteresis 272
- Trigger Drop-Out Time 273
- Trigger Holdoff 274

Trigger Source

The trigger source defines which source must fulfill the condition that triggers the measurement. Basically, this can be:

- Time: the measurement is repeated in a regular interval
- Power: an input signal is checked for a defined power level
  The trigger signal can be any of the following:
  - The input signal at one of various stages in the signal analysis process - before or after the input mixer, after the video filter etc.
  - A signal from an external device via one of the TRIGGER connectors on the instrument
  - A signal from a power sensor, see "Using a Power Sensor as an External Power Trigger" on page 199.

For details on the available trigger sources see "Trigger Source" on page 279.

Trigger Offset

An offset can be defined to delay the measurement after the trigger event, or to include data before the actual trigger event in time domain measurements (pre-trigger offset). Pre-trigger offsets are possible because the R&S FSWP captures data continuously in the time domain, even before the trigger occurs.

See "Trigger Offset" on page 282.

Trigger Hysteresis

Setting a hysteresis for the trigger helps avoid unwanted trigger events caused by noise, for example. The hysteresis is a threshold to the trigger level that the signal must fall below on a rising slope or rise above on a falling slope before another trigger event occurs.

Example:

In the following example, the second possible trigger event is ignored as the signal does not exceed the hysteresis (threshold) before it reaches the trigger level again on the rising edge. On the falling edge, however, two trigger events occur as the signal exceeds the hysteresis before it falls to the trigger level the second time.

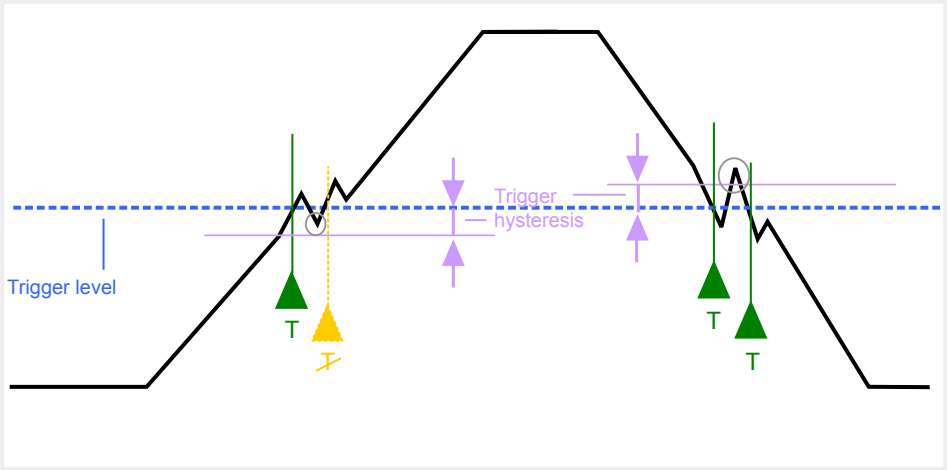


Fig. 3-19: Effects of the trigger hysteresis

See "Hysteresis" on page 283

Trigger Drop-Out Time

If a modulated signal is instable and produces occassional "drop-outs" during a burst, you can define a minimum duration that the input signal must stay below the trigger level before triggering again. This is called the "drop-out" time. Defining a dropout time helps you stabilize triggering when the analyzer is triggering on undesired events.

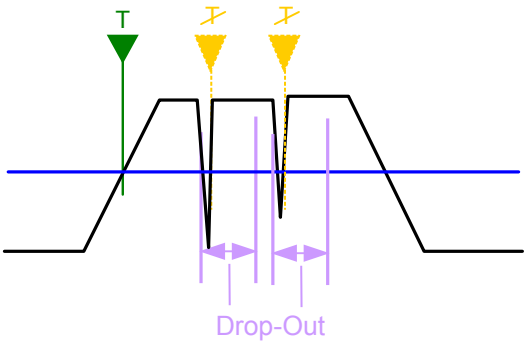


Fig. 3-20: Effect of the trigger drop-out time

See "Drop-Out Time" on page 282.

Drop-out times for falling edge triggers

If a trigger is set to a falling edge ("Slope" = "Falling", see "Slope" on page 283) the measurement is to start when the power level falls below a certain level. This is useful, for example, to trigger at the end of a burst, similar to triggering on the rising edge for the beginning of a burst.

If a drop-out time is defined, the power level must remain below the trigger level at least for the duration of the drop-out time (as defined above). However, if a drop-out time is defined that is longer than the pulse width, this condition cannot be met before the final pulse, so a trigger event will not occur until the pulsed signal is over!

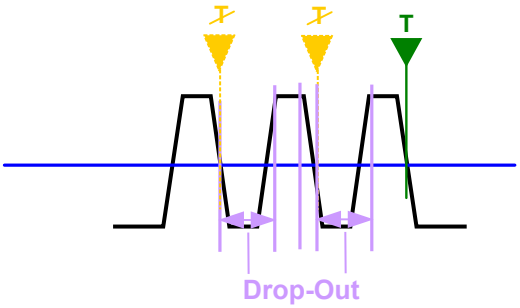


Fig. 3-21: Trigger drop-out time for falling edge trigger

For gated measurements, a combination of a falling edge trigger and a drop-out time is generally not allowed.

Trigger Holdoff

The trigger holdoff defines a waiting period before the next trigger after the current one will be recognized.

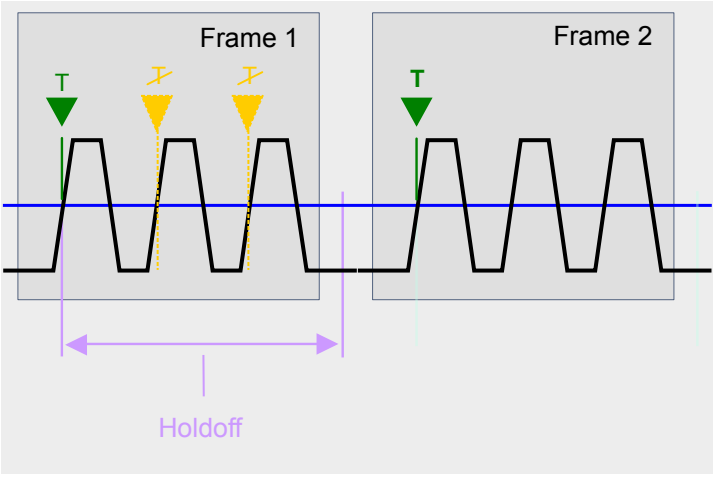


Fig. 3-22: Effect of the trigger holdoff

See "Trigger Holdoff" on page 283.

3.6.1.2 Gated Measurements

Like a gate provides an opening in a fence, a gated measurement lets data from the input signal pass in defined areas only. The *gate* controls exactly when data is included in the measurement results and when not. The gate is opened by the trigger source, which is also the gate source. Gates can be used in two different modes:

- **Level:** The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the gate source drops below the "Gate Level".
  Using a pulsed gate signal in level mode, the following behaviour can be achieved: When the gate source signal is active, the input signal data is collected; when the gate signal is inactive, the input signal is ignored.
- **Edge:** The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the defined "Gate Length" is reached.

The "Gate Mode" *Level* is not supported for Rohde & Schwarz power sensors. The signal sent by these sensors merely reflects the instant the level is first exceeded, rather than a time period. However, only time periods can be used for gating in level mode. Thus, the trigger impulse from the sensors is not long enough for a fully gated measurement; the measurement cannot be completed. For details on power sensors see "Using a Power Sensor as an External Power Trigger" on page 199.

Additionally, a delay time can be defined so that the first few measurement points after the gate opening are ignored.

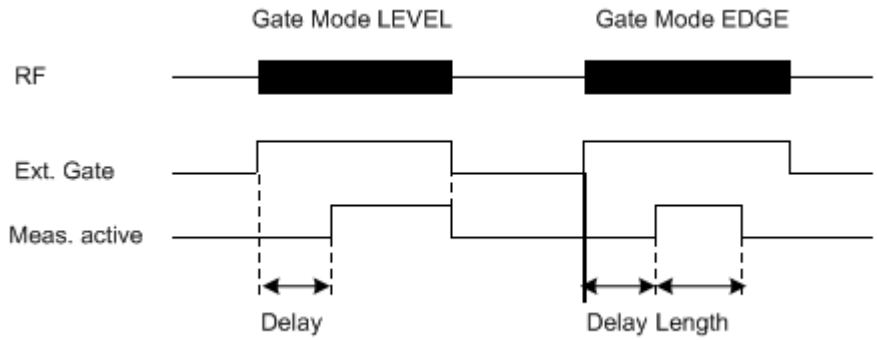


Fig. 3-23: Effects of Gate mode, Gate delay and Gate length

Example:

By using a gate in sweep mode and stopping the measurement while the gate signal is inactive, the spectrum for pulsed RF carriers can be displayed without the superposition of frequency components generated during switching. Similarly, the spectrum can also be analyzed for an inactive carrier. The sweep can be controlled by an external gate or by the internal power trigger.

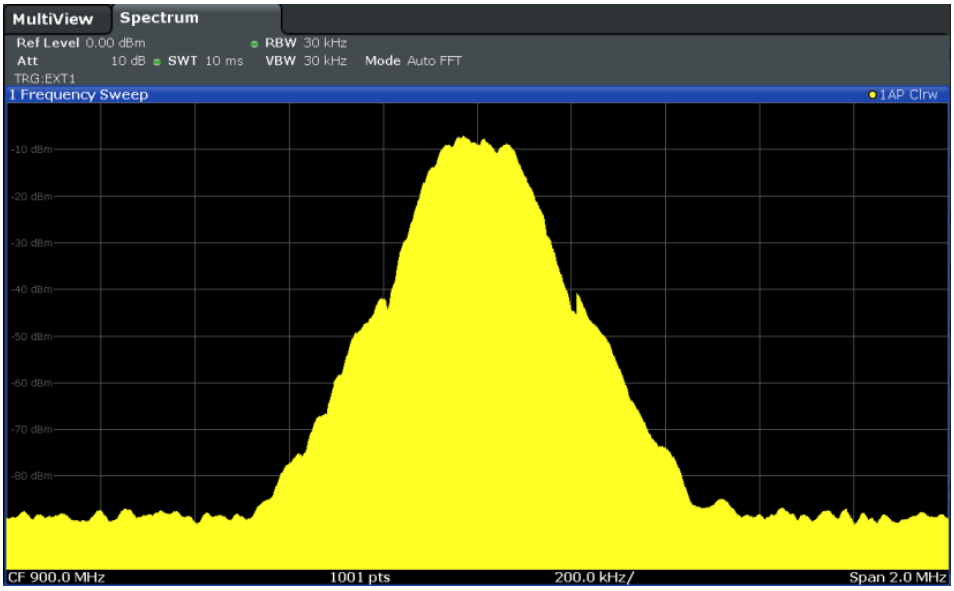


Fig. 3-24: GSM signal with GATE OFF

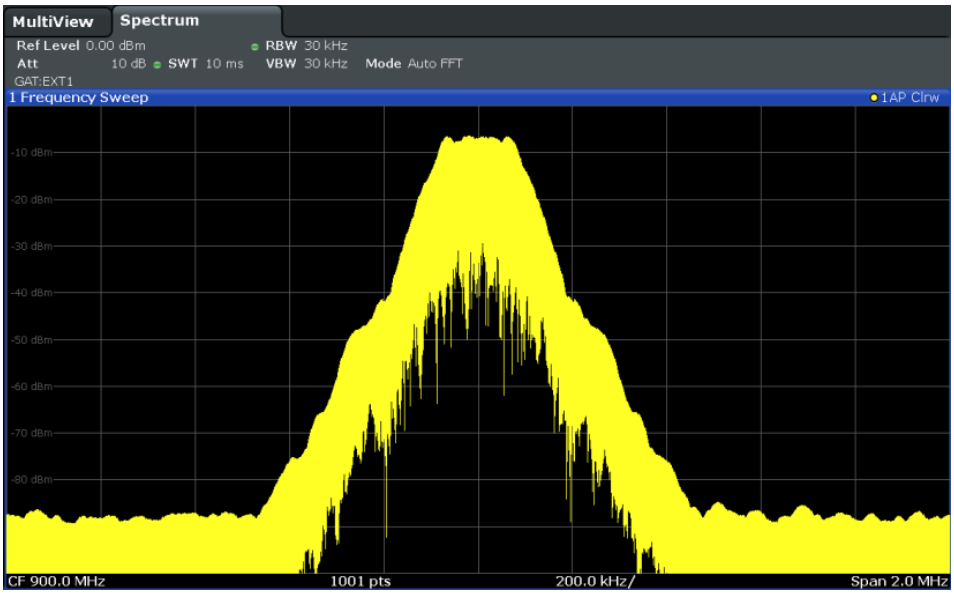


Fig. 3-25: GSM signal with GATE ON

Gated sweep operation is also possible for zero span measurements. This allows you to display level variations of individual slots, for instance in burst signals, versus time.

To indicate that a gate is used for the sweep, "GAT" and the gate source is displayed in the channel bar.

3.6.1.3 Determining the Parameters in Preview Mode

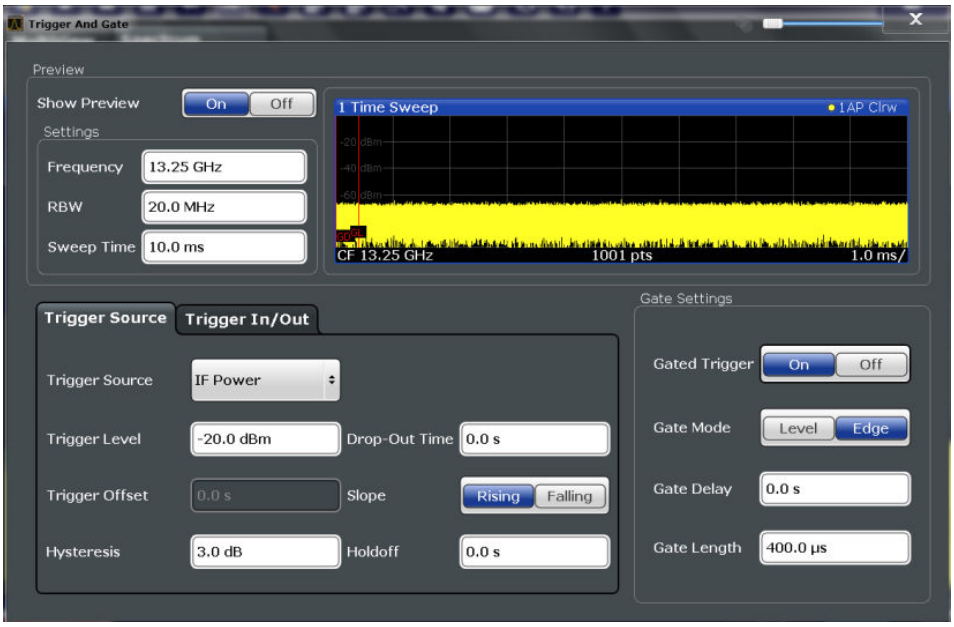
The preview mode allows you to try out trigger and gate settings before actually applying them to the current measurement. When the preview diagram shows the correct results, you can "Update the Main Diagram" and check the results in the background before closing the dialog box.

If preview mode is switched off, changes to the trigger and gate settings are applied to the measurement diagram directly.

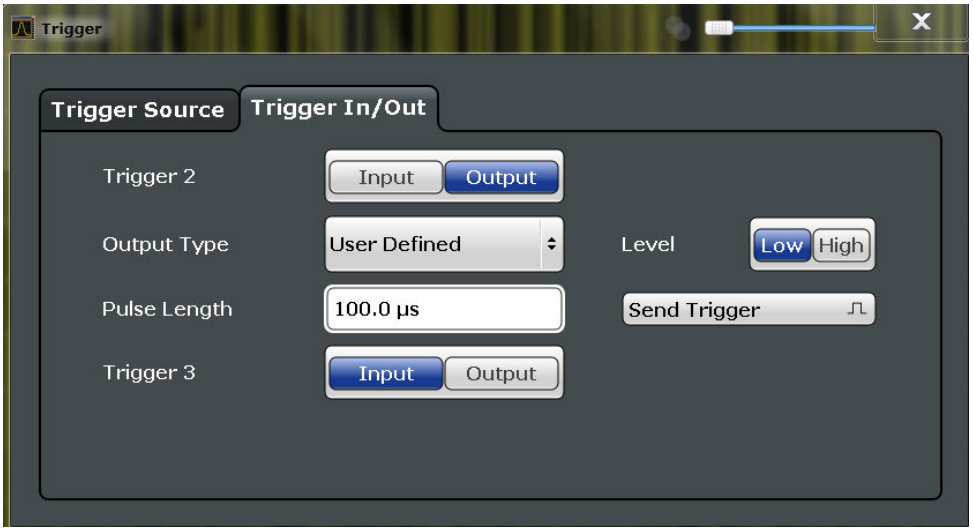
The preview diagram displays a zero span measurement at the center frequency with the defined RBW and sweep time. This is useful to analyze bursts, for example, to determine the required gate settings. The main diagram remains unchanged concerning the zero span settings. Only the trigger and gate settings are applied to the measurement.

3.6.2 Trigger and Gate Settings

Trigger and gate settings can be configured via the TRIG key or in the "Trigger and Gate" dialog box, which is displayed when you select the "Trigger/Gate" button in the "Overview".



External triggers from one of the TRIGGER connectors on the R&S FSWP are configured in a separate tab of the dialog box.



For step-by-step instructions on configuring triggered and gated measurements, see chapter 3.6.3, "How to Configure a Triggered and Gated Measurement", on page 285.

Preview 279
- Frequency 279
- RBW 279
- Sweep Time 279

Trigger Settings 279
- Trigger Source 279
  - Free Run 280
  - Ext. Trigger 1/2 280
  - Video 280
  - IF Power 280
  - RF Power 281
  - Power Sensor 281
  - Time 282
- Trigger Level 282
- Repetition Interval 282
- Drop-Out Time 282
- Trigger Offset 282
- Hysteresis 283
- Trigger Holdoff 283
- Slope 283

Trigger 1/2 283
- Output Type 284
  - Level 284
  - Pulse Length 284
  - Send Trigger 284

Gate Settings 284
- Gated Trigger 284
- Gate Mode 285
- Gate Delay 285
- Gate Length 285

Preview
The preview diagram displays a zero span measurement at the center frequency with the defined RBW and sweep time.

For details see chapter 3.6.1.3, "Determining the Parameters in Preview Mode", on page 277.

Note: The zero span settings refer only to the preview diagram. The main diagram remains unchanged.

The trigger and gate settings are applied to the measurement when the dialog box is closed or "Update Main Diagram" is selected.

If preview mode is switched off, any changes to the settings in this dialog box are applied to the measurement diagram directly. In this case, the zero span settings for the preview diagram are not displayed.

For information on the zero span settings see:
- "Center frequency" on page 242
- "RBW" on page 263
- "Sweep Time" on page 263

Frequency ← Preview
Defines the center frequency.

Remote command:
`[SENSe:]FREQuency:CENTer` on page 570

RBW ← Preview
Defines the bandwidth value. The available resolution bandwidths are specified in the data sheet. Numeric input is always rounded to the nearest possible bandwidth.

Remote command:
`[SENSe:]BANDwidth[:RESolution]` on page 581

Sweep Time ← Preview
Defines the sweep time. Allowed values depend on the ratio of span to RBW and RBW to VBW. For details refer to the data sheet. Numeric input is always rounded to the nearest possible sweep time.

Remote command:
`[SENSe:]SWEep:TIME` on page 588

Trigger Settings
The trigger settings define the beginning of a measurement.

Trigger Source ← Trigger Settings
Selects the trigger source. If a trigger source other than "Free Run" is set, "TRG" is displayed in the channel bar and the trigger source is indicated.

For gated measurements, this setting also selects the gating source.

For more information see "Trigger Source" on page 272.

Remote command:
`TRIGger[:SEQuence]:SOURce` on page 592
`[SENSe:]SWEep:EGATe:SOURce` on page 595

Free Run ← Trigger Source ← Trigger Settings
No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitely.

In its default state, the R&S FSWP performs free run measurements.

Remote command:
`TRIG:SOUR IMM`, see `TRIGger[:SEQuence]:SOURce` on page 592

Ext. Trigger 1/2 ← Trigger Source ← Trigger Settings
Data acquisition starts when the TTL signal fed into the specified input connector meets or exceeds the specified trigger level.

Note: The "External Trigger 1" softkey automatically selects the trigger signal from the TRIGGER 1 INPUT / OUTPUT connector on the front panel.

For details see the "Instrument Tour" chapter in the R&S FSWP Getting Started manual.

"External Trigger 1"
Trigger signal from the TRIGGER 1 INPUT / OUTPUT connector. (front panel)

"External Trigger 2"
Trigger signal from the TRIGGER 2 INPUT / OUTPUT connector. (rear panel)
Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 1/2" on page 236).

Remote command:
`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`
See `TRIGger[:SEQuence]:SOURce` on page 592

Video ← Trigger Source ← Trigger Settings
Defines triggering by the video signal, i.e. the filtered and detected version of the input signal (the envelope of the IF signal), as displayed on the screen.

Define a trigger level from 0 % to 100 % of the diagram height. The absolute trigger level is indicated by a horizontal trigger line in the diagram, which you can also move graphically to change the trigger level.

Video mode is only available in the time domain, and not for I/Q-based data.

Remote command:
`TRIG:SOUR VID`, see `TRIGger[:SEQuence]:SOURce` on page 592
`SWE:EGAT:SOUR VID` for gated triggering, see `[SENSe:]SWEep:EGATe:SOURce` on page 595

IF Power ← Trigger Source ← Trigger Settings
The R&S FSWP starts capturing data as soon as the trigger level is exceeded around the third intermediate frequency.

For frequency sweeps, the third IF represents the start frequency. The trigger bandwidth at the third IF depends on the RBW and sweep type.

For measurements on a fixed frequency (e.g. zero span or I/Q measurements), the third IF represents the center frequency.

This trigger source is only available for RF input.

The available trigger levels depend on the RF attenuation and preamplification. A reference level offset, if defined, is also considered.

For details on available trigger levels and trigger bandwidths see the data sheet.

Note: Be aware that in auto sweep type mode, due to a possible change in sweep types, the trigger bandwidth may vary considerably for the same RBW setting.

Remote command:
`TRIG:SOUR IFP`, see `TRIGger[:SEQuence]:SOURce` on page 592
`SWE:EGAT:SOUR IFP` for gated triggering, see `[SENSe:]SWEep:EGATe:SOURce` on page 595

RF Power ← Trigger Source ← Trigger Settings
Defines triggering of the measurement via signals which are outside the displayed measurement range.

For this purpose the instrument uses a level detector at the first intermediate frequency.

The input signal must be in the frequency range between 500 MHz and 8 GHz.

The resulting trigger level at the RF input depends on the RF attenuation and preamplification. For details on available trigger levels see the instrument's data sheet.

Note: If the input signal contains frequencies outside of this range (e.g. for fullspan measurements), the measurement may be aborted and a message indicating the allowed input frequencies is displayed in the status bar.

A "Trigger Offset", "Trigger Polarity" and "Trigger Holdoff" (to improve the trigger stability) can be defined for the RF trigger, but no "Hysteresis".

Remote command:
`TRIG:SOUR RFP`, see `TRIGger[:SEQuence]:SOURce` on page 592
`SWE:EGAT:SOUR RFP` for gated triggering, see `[SENSe:]SWEep:EGATe:SOURce` on page 595

Power Sensor ← Trigger Source ← Trigger Settings
Uses an external power sensor as a trigger source. This option is only available if a power sensor is connected and configured.

(See chapter 3.2.3.3, "How to Work With a Power Sensor", on page 205.)

If a power sensor is selected as the trigger mode, the following softkeys are not available; these settings are configured in the "Power Sensor Configuration" dialog box (seechapter 3.2.3.2, "Power Sensor Settings", on page 200).

- "Trigger Level" on page 282
- "Slope" on page 283
- "Hysteresis" on page 283
- "Trigger Holdoff" on page 283

Note: For R&S power sensors, the "Gate Mode" *Lvl* is not supported. The signal sent by these sensors merely reflects the instant the level is first exceeded, rather than a time period. However, only time periods can be used for gating in level mode. Thus,

the trigger impulse from the sensors is not long enough for a fully gated measurement; the measurement cannot be completed.

Remote command:
`TRIG:SOUR PSE`, see `TRIGger[:SEQuence]:SOURce` on page 592
`SWE:EGAT:SOUR PSE` for gated triggering, see `[SENSe:]SWEep:EGATe:SOURce` on page 595

Time ← Trigger Source ← Trigger Settings
Triggers in a specified repetition interval.

Remote command:
`TRIG:SOUR TIME`, see `TRIGger[:SEQuence]:SOURce` on page 592

Trigger Level ← Trigger Settings
Defines the trigger level for the specified trigger source.

For gated measurements, this setting also defines the gate level.

For details on supported trigger levels, see the data sheet.

Remote command:
`TRIGger[:SEQuence]:LEVel:IFPower` on page 591
`TRIGger[:SEQuence]:LEVel:IQPower` on page 591
`TRIGger[:SEQuence]:LEVel[:EXTernal<port>]` on page 591
`TRIGger[:SEQuence]:LEVel:RFPower` on page 592

Repetition Interval ← Trigger Settings
Defines the repetition interval for a time trigger. The shortest interval is 2 ms.

The repetition interval should be set to the exact pulse period, burst length, frame length or other repetitive signal characteristic.

Remote command:
`TRIGger[:SEQuence]:TIME:RINTerval` on page 593

Drop-Out Time ← Trigger Settings
Defines the time the input signal must stay below the trigger level before triggering again.

For more information on the drop-out time see "Trigger Drop-Out Time" on page 273.

Remote command:
`TRIGger[:SEQuence]:DTIMe` on page 589

Trigger Offset ← Trigger Settings
Defines the time offset between the trigger event and the start of the measurement.

For more information see "Trigger Offset" on page 272.

offset > 0:	Start of the measurement is delayed
offset < 0:	Measurement starts earlier (pre-trigger) Only possible for zero span (e.g. I/Q Analyzer application) and gated trigger switched off Maximum allowed range limited by the measurement time: $pretrigger_{max}$ = $measurement\ time_{max}$

Remote command:
`TRIGger[:SEQuence]:HOLDoff[:TIME]` on page 590

Hysteresis ← Trigger Settings
Defines the distance in dB to the trigger level that the trigger source must exceed before a trigger event occurs. Settting a hysteresis avoids unwanted trigger events caused by noise oscillation around the trigger level.

This setting is only available for "IF Power" trigger sources. The range of the value is between 3 dB and 50 dB with a step width of 1 dB.

For more information see "Trigger Hysteresis" on page 272.

Remote command:
`TRIGger[:SEQuence]:IFPower:HYSTeresis` on page 590

Trigger Holdoff ← Trigger Settings
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

For more information see "Trigger Holdoff" on page 274.

Remote command:
`TRIGger[:SEQuence]:IFPower:HOLDoff` on page 590

Slope ← Trigger Settings
For all trigger sources except time you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

For gated measurements in "Edge" mode, the slope also defines whether the gate starts on a falling or rising edge.

Remote command:
`TRIGger[:SEQuence]:SLOPe` on page 592
`[SENSe:]SWEep:EGATe:POLarity` on page 595

Trigger 1/2
Access: "Overview" > "Trigger" > "Trigger In/Out"

Defines the usage of the variable TRIGGER INPUT/OUTPUT connectors, where:

"Trigger 1": TRIGGER INPUT/OUTPUT connector on the front panel

"Trigger 2": TRIGGER INPUT/OUTPUT connector on the front panel

"Input" The signal at the connector is used as an external trigger source by the R&S FSWP. Trigger input parameters are available in the "Trigger" dialog box.

"Output" The R&S FSWP sends a trigger signal to the output connector to be used by connected devices.
Further trigger parameters are available for the connector.

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 567
`OUTPut:TRIGger<port>:DIRection` on page 567

Output Type ← Trigger 1/2
Type of signal to be sent to the output

"Device Triggered" (Default) Sends a trigger when the R&S FSWP triggers.

"Trigger Armed" Sends a (high level) trigger when the R&S FSWP is in "Ready for trigger" state.
This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low level signal at the AUX port (pin 9).

"User Defined" Sends a trigger when user selects "Send Trigger" button.
In this case, further parameters are available for the output signal.

Remote command:
`OUTPut:TRIGger<port>:OTYPe` on page 567

Level ← Output Type ← Trigger 1/2
Defines whether a constant high (1) or low (0) signal is sent to the output connector.

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 567

Pulse Length ← Output Type ← Trigger 1/2
Defines the length of the pulse sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 568

Send Trigger ← Output Type ← Trigger 1/2
Sends a user-defined trigger to the output connector immediately. Note that the trigger pulse level is always opposite to the constant signal level defined by the output "Level" setting, e.g. for "Level = High", a constant high signal is output to the connector until the "Send Trigger" button is selected. Then, a low pulse is sent.

Which pulse level will be sent is indicated by a graphic on the button.

Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 568

Gate Settings
Gate settings define one or more extracts of the signal to be measured.

Note: Gating is not available for measurements on I/Q-based data.

Gated Trigger ← Gate Settings
Switches gated triggering on or off.

If the gate is switched on, a gate signal applied to one of the "TRIGGER INPUT" connectors or the internal IF power detector controls the sweep of the analyzer.

Gate Mode ← Gate Settings
Sets the gate mode.

For more information see chapter 3.6.1.2, "Gated Measurements", on page 275

"Edge" The trigger event for the gate to open is the detection of the signal edge.
After the gate signal has been detected, the gate remains open until the gate length is over.

"Level" The trigger event for the gate to open is a particular power level.
After the gate signal has been detected, the gate remains open until the signal disappears.
Note: If you perform gated measurements in combination with the IF Power trigger, the R&S FSWP ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q mode measurements.

Remote command:
`[SENSe:]SWEep:EGATe:TYPE` on page 596

Gate Delay ← Gate Settings
Defines the delay time between the gate signal and the continuation of the measurement. The delay position on the time axis in relation to the sweep is indicated by a line labeled "GD".

For more information see chapter 3.6.1.2, "Gated Measurements", on page 275

Remote command:
`[SENSe:]SWEep:EGATe:HOLDoff` on page 594

Gate Length ← Gate Settings
Defines how long the gate is open when it is triggered. The gate length can only be set in the edge-triggered gate mode. In the level-triggered mode the gate length depends on the level of the gate signal.

The gate length in relation to the sweep is indicated by a line labeled "GL".

For more information see chapter 3.6.1.2, "Gated Measurements", on page 275

Remote command:
`[SENSe:]SWEep:EGATe:LENGth` on page 595

3.6.3 How to Configure a Triggered and Gated Measurement

The following step-by-step instructions demonstrate how to configure a triggered and gated measurement manually.

Trigger and gate settings are configured in the "Trigger and Gate" dialog box.

To display the "Trigger and Gate" dialog box, do one of the following:

- Select "Trigger/Gate" from the "Overview".
- Select the TRIG key and then the "Trigger/Gate Config" softkey.

The following tasks are described:

3.6.3.1 How to Determine the Required Trigger/Gate Parameters..... 286
3.6.3.2 How to Configure a Triggered Measurement..... 286
3.6.3.3 How to Configure a Gated Measurement..... 287

3.6.3.1 How to Determine the Required Trigger/Gate Parameters

1. In the "Trigger and Gate" dialog box, switch on "Show Preview".

   A zero span measurement for the currently defined center frequency is displayed.

2. Set the "Frequency", "RBW" and "Sweep Time" such that the relevant part of the signal is displayed, for example a complete burst.

3. Determine the parameters you want to use to define the trigger and gate conditions from the preview diagram, for example:

   - the length of a burst or slot
   - the upper or lower power level of a pulse
   - the maximum noise level
   - the power level or time at which a certain incident occurs

4. Try out different trigger and gate settings as described in How to Configure a Triggered Measurement and How to Configure a Gated Measurement, then select "Update Main Diagram" to see the effect of the current settings on the main measurement in the background.

5. If the results are as expected, close the dialog box to keep the changes permanently. Otherwise, correct the settings as necessary.

3.6.3.2 How to Configure a Triggered Measurement

To define a time trigger:

1. In the "Trigger and Gate" dialog box, define the "Trigger Source" = "Time".

2. Define the "Repetition Interval": the time after which a new measurement is started.

To define an external trigger:

1. Connect an external device that will provide the trigger signal to one of the trigger connectors on the R&S FSWP (for details see the R&S FSWP "Getting Started" manual).

2. In the "Trigger and Gate" dialog box, define the "Trigger Source" = "External".

3. If you are using the variable TRIGGER 2 INPUT / OUTPUT connector, you must define its use as an input connector. In the "Trigger In/Out" tab of the "Trigger and Gate" dialog box, set the corresponding trigger to "Input".

4. Configure the external trigger as described for the other power triggers.

To define a power trigger:

1. In the "Trigger and Gate" dialog box, define the "Trigger Source" = "IF Power" or "Video". Note that the video signal corresponds to the envelope of the IF signal: it has been processed by the resolution and video filters and the selected detector.
2. Define the "Trigger Level": the power level at which the measurement will start. For a "Video" trigger source you can move the level line graphically to define the level. If you define the value numerically, you must enter a percentage of the full diagram height as the level.
3. Define whether the signal must cross the trigger level on a falling or on a rising edge ("Slope") to trigger the measurement.
4. To start the measurement with a time delay, define a "Trigger Offset".
5. To reject triggers due to noise or jittering in the signal, define a "Hysteresis" that is larger than the expected noise or jittering. After the previous trigger, the signal must exceed this threshold before the next level crossing triggers a new measurement.
6. To skip multiple triggers in a burst, define a "Holdoff" time that must pass between two triggers. The holdoff time should be slightly larger than the burst.

3.6.3.3 How to Configure a Gated Measurement

1. Determine the required parameters as described in chapter 3.6.3.1, "How to Determine the Required Trigger/Gate Parameters", on page 286.
2. The gate is opened by a trigger event, which must be based on a power source. Define the trigger as described in chapter 3.6.3.2, "How to Configure a Triggered Measurement", on page 286. As the "Trigger Source", use "IF Power", "Video" or "External".
3. Define how long the gate is to remain open:
   To measure the signal as long as the trigger level is exceeded, for example for one or more pulses, define "Gate Mode" = "Level".
   To measure the signal for a certain time after a level is exceeded, for example during a burst:
   a) Define "Gate Mode" = "Edge".
   b) Define the time to measure for each gate: "Gate Length".
4. To open the gate with a time delay, for example to ignore an overshoot, define a "Gate Delay".
5. Select "Gated Trigger" = "On".

3.6.4 How to Output a Trigger Signal

Using the variable TRIGGER 2 INPUT / OUTPUT connector of the R&S FSWP, the internal trigger signal can be output for use by other connected devices. For details on the connectors see the R&S FSWP "Getting Started" manual.

To output a trigger to a connected device

1. In the "Trigger In/Out" tab of the "Trigger and Gate" dialog box, set the trigger to be used to "Output".
2. Define whether the trigger signal is to be output automatically ("Output Type" = "Device triggered" or "Trigger Armed") or whether you want to start output manually ("Output Type" = "User-defined").
3. For manual output: Specify the constant signal level and the length of the trigger pulse to be output. Note that the level of the trigger pulse is opposite to the constant output "Level" setting (compare the graphic on the "Send Trigger" button).
4. Connect a device that will receive the trigger signal to the configured TRIGGER 2 INPUT / OUTPUT connector.
5. Start a measurement and wait for an internal trigger, or select the "Send Trigger" button.

   The configured trigger is output to the connector.

3.7 Adjusting Settings Automatically

Some settings can be adjusted by the R&S FSWP automatically according to the current measurement settings. In order to do so, a measurement is performed. The duration of this measurement can be defined automatically or manually.

To activate the automatic adjustment of a setting, select the corresponding function in the AUTO SET menu or in the configuration dialog box for the setting, where available.

MSRA operating mode

In MSRA operating mode, settings related to data acquisition can only be adjusted automatically for the MSRA Master, not the applications.

Adjusting settings automatically during triggered measurements

When you select an auto adjust function a measurement is performed to determine the optimal settings. If you select an auto adjust function for a triggered measurement, you are asked how the R&S FSWP should behave:

- (default:) The measurement for adjustment waits for the next trigger
- The measurement for adjustment is performed without waiting for a trigger.
  The trigger source is temporarily set to "Free Run". After the measurement is completed, the original trigger source is restored. The trigger level is adjusted as follows:
  – For IF Power and RF Power triggers:
  Trigger Level = Reference Level - 15 dB
  – For Video trigger:
  Trigger Level = 85 %

Remote command:

`[SENSe:]ADJust:CONFigure:TRIG` on page 599

Adjusting all Determinable Settings Automatically (Auto All)..... 289
Adjusting the Center Frequency Automatically (Auto Freq)..... 289
Setting the Reference Level Automatically (Auto Level)..... 290
Resetting the Automatic Measurement Time (Meastime Auto)..... 290
Changing the Automatic Measurement Time (Meastime Manual)..... 290
Upper Level Hysteresis..... 290
Lower Level Hysteresis..... 290

Adjusting all Determinable Settings Automatically (Auto All)

Activates all automatic adjustment functions for the current measurement settings.

This includes:

- Auto Frequency
- Auto Level

Note: MSRA operating modes. In MSRA operating mode this function is only available for the MSRA Master, not the applications.

Remote command:

`[SENSe:]ADJust:ALL` on page 597

Adjusting the Center Frequency Automatically (Auto Freq)

The R&S FSWP adjusts the center frequency automatically.

The optimum center frequency is the frequency with the highest S/N ratio in the frequency span. As this function uses the signal counter, it is intended for use with sinusoidal signals.

Remote command:

`[SENSe:]ADJust:FREQuency` on page 599

Setting the Reference Level Automatically (Auto Level)
Automatically determines the optimal reference level for the current input data. At the same time, the internal attenuators are adjusted so the signal-to-noise ratio is optimized, while signal compression, clipping and overload conditions are minimized.

To determine the optimal reference level, a level measurement is performed on the R&S FSWP.

You can change the measurement time for the level measurement if necessary (see "Changing the Automatic Measurement Time (Meastime Manual)" on page 290).

Remote command:
[SENSe:]ADJust:LEVel on page 599

Resetting the Automatic Measurement Time (Meastime Auto)
Resets the measurement duration for automatic settings to the default value.

(Spectrum application: 1 ms)

Remote command:
[SENSe:]ADJust:CONFigure:DURation:MODE on page 597

Changing the Automatic Measurement Time (Meastime Manual)
This function allows you to change the measurement duration for automatic setting adjustments. Enter the value in seconds.

Remote command:
[SENSe:]ADJust:CONFigure:DURation:MODE on page 597
[SENSe:]ADJust:CONFigure:DURation on page 597

Upper Level Hysteresis
When the reference level is adjusted automatically using the Auto Level function, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Remote command:
[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer on page 598

Lower Level Hysteresis
When the reference level is adjusted automatically using the Auto Level function, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Remote command:
[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer on page 598

3.8 Transducer

- Basics on Transducer Factors 291
- Transducer Settings 292
- How to Configure the Transducer 297

3.8.1 Basics on Transducer Factors

The transducer allows you to manipulate the trace at discrete trace points to correct the signal coming from an input device. Transducers are often used to correct the frequency response for antennas, for example. The transducer is configured by defining transducer factors for specific trace points. A set of transducer factors defines an interpolated transducer line and can be stored on the instrument.

In the Spectrum application, the correction factor from all active transducers is calculated for each displayed trace point once in advance and is added to the result of the level measurement during the sweep. If the sweep range changes, the correction values are calculated again. If several measured values are combined in one point, only one value is taken into consideration. If the active transducer line is not defined for the entire sweep range, the missing values are replaced by zeroes.

When a transducer is used, the trace is shifted by a calculated factor. However, an upward shift reduces the dynamic range for the displayed values. Thus, the reference level can be adapted automatically to restore the original dynamic range. The reference level is shifted by the maximum transducer factor. By default, if transducers are active the reference level function is adapted automatically to obtain the best dynamic performance.

If a transducer factor is active, "TDF" is displayed in the channel bar.

Y-Axis Unit

The individual transducer factors can be defined as absolute values or relative (dB) values. However, all factors for one transducer line use the same unit. As soon as a transducer is activated, the unit of the transducer is automatically used for all the level settings and outputs. The unit cannot be changed in the amplitude settings since the R&S FSWP and the active transducer are regarded as one measuring instrument. Only for relative transducer factors (unit dB), the unit originally set on the instrument is maintained and can be changed.

When all transducers have been switched off, the R&S FSWP returns to the unit that was used before a transducer was activated.

Configuration

The R&S FSWP supports transducer lines with a maximum of 1001 data points. Eight of the transducer lines stored in the instrument can be activated simultaneously. The number of transducer lines stored in the instrument is only limited by the capacity of the storage device used.

A transducer line consists of the following data:

- A maximum of 1001 data points with a position and value
- A unit for the values
- A name to distinguish the transducer lines

Validity

The transducer factors must comply with the following rules to ensure correct operation:

- The frequencies for the data points must always be defined in ascending order. Otherwise the entry will not be accepted and the an error message is displayed.
- The frequencies of the data points may exceed the valid frequency range of the R&S FSWP since only the set frequency range is taken into account for measurements. The minimum frequency of a data point is 0 Hz, the maximum frequency 200 GHz.
- The value range for the transducer factor is ±200 dB.
- Gain has to be entered as a negative value, and attenuation as a positive value.

Storing transducer factors

Transducer factors can be stored with the configuration settings so they can be recalled for other measurements at a later time. Note, however, that any changes made to the transducer factors *after* storing the configuration file cannot be restored and will be overwritten by the stored values when the configuration file is recalled. Always remember to store the settings again after changing the transducer factors.

Recalling transducer factors

After recalling measurement settings, the transducer factors applied to the measurement may be different to those displayed in the "Transducer" dialog box.

3.8.2 Transducer Settings

Access: SETUP > "Transducer"

Up to 8 transducer lines can be activated simultaneously in the R&S FSWP. Many more can be stored on the instrument.

Stored transducer settings

If a transducer file was in use when the save set was stored (with the save item "Current Settings" only) it is anticipated that these transducer values should remain valid after every recall of that save set. Thus, even if the transducer file is changed and the original save set file is recalled later, the *originally stored* transducer values are recalled and applied to the measurement. In the "Edit transducer" dialog box, however, the *changed* transducer file values are displayed as no updated transducer file was loaded.

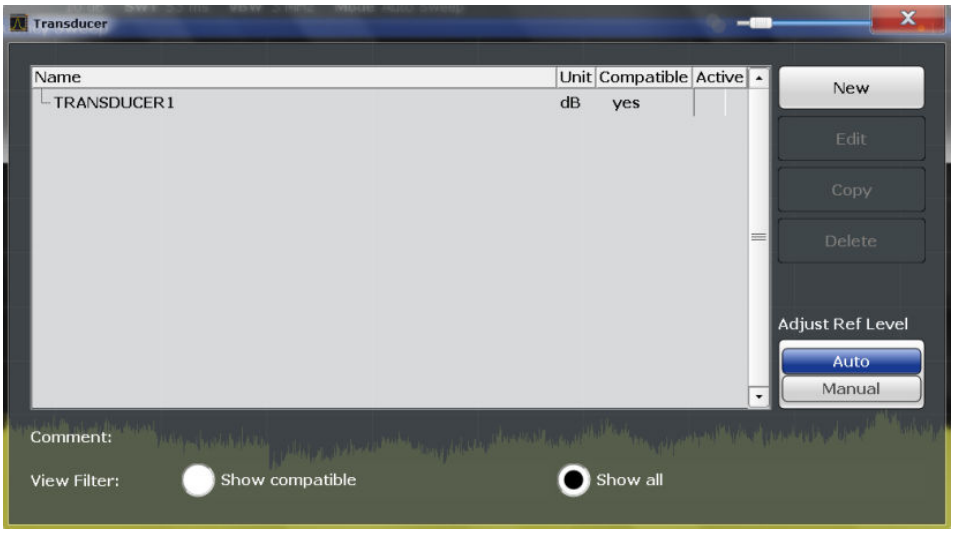
For more information see the R&S FSWP User Manual.

- Transducer Management....293
- Transducer Factors....295

3.8.2.1 Transducer Management

Access: SETUP > "Transducer"

The settings required to manage all transducer lines on the instrument are described here.



For the transducer line overview, the R&S FSWP searches for all stored transducer lines with the file extension `.TDF` in the `trd` subfolder of the main installation folder. The overview allows you to determine which transducer lines are available and can be used for the current measurement.

For details on settings for individual lines see chapter 3.8.2.2, "Transducer Factors", on page 295.

For instructions on configuring and working with transducers see chapter 3.8.3, "How to Configure the Transducer", on page 297.

Name....294
Unit....294
Compatibility....294

Activating/Deactivating....294
Comment....294
Included Transducer Lines in Overview (View Filter)....294
Adjusting the Reference Level....294
Create New Line....295
Edit Line....295
Copy Line....295
Delete Line....295

Name
The name of the stored transducer line.

Unit
The unit in which the y-values of the data points of the transducer line are defined.

The following units are available:
- dB
- dBm
- dBmV
- dBµV
- dBµV/m
- dBµA
- dBµA/m
- dBpW
- dBpT

Compatibility
Indicates whether the transducer factors are compatible with the current measurement settings.

For more information on which conditions a transducer line must fulfill to be compatible, see chapter 3.8.1, "Basics on Transducer Factors", on page 291.

Activating/Deactivating
Activates/deactivates the transducer line. Up to 8 transducer lines can be active at the same time.

Remote command:
`[SENSe:]CORRection:TRANsducer:SELect` on page 601
`[SENSe:]CORRection:TRANsducer[:STATe]` on page 602

Comment
An optional description of the transducer line.

Included Transducer Lines in Overview (View Filter)
Defines which of the stored transducer lines are included in the overview. The view can be restricted to compatible transducer lines only or include all transducer lines found. Whether a line is compatible or not is indicated in the Compatibility setting.

Adjusting the Reference Level
Activates or deactivates the automatic adjustment of the reference level to the selected transducer factor.

"Auto" Activates the automatic adjustment. The original dynamic range is restored by shifting the reference level by the maximum transducer factor.

"Man" Deactivates the automatic adjustment. Adjust the reference level via the "Amplitude" menu.

Remote command:
`[SENSe:]CORRection:TRANsducer:ADJust:RLEVel[:STATe]` on page 600

Create New Line
Create a new transducer line.

Remote command:
`[SENSe:]CORRection:TRANsducer:SELect` on page 601

Edit Line
Edit an existing transducer line configuration.

Copy Line
Copy the selected transducer line configuration to create a new line.

Delete Line
Delete the selected transducer line.

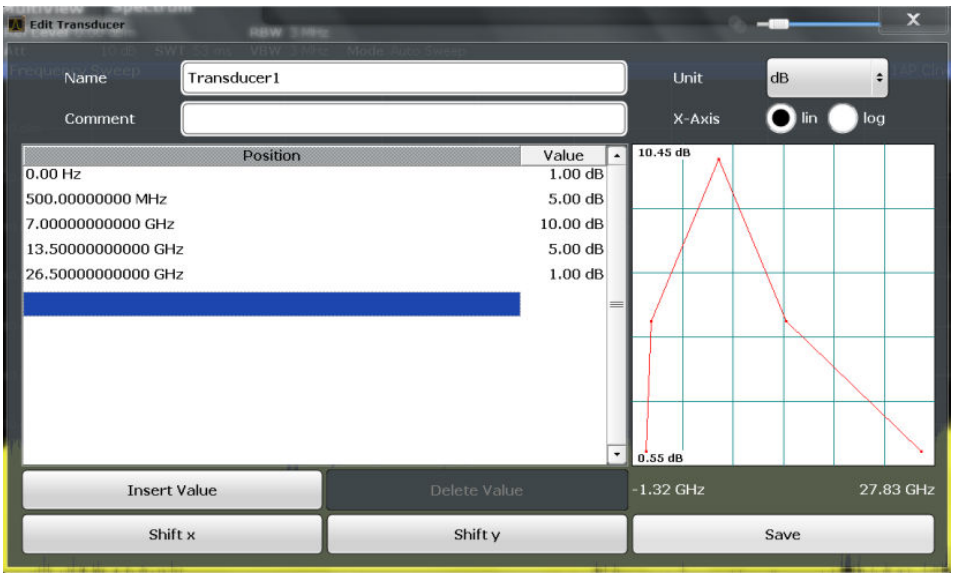
Remote command:
`[SENSe:]CORRection:TRANsducer:DELete` on page 601

3.8.2.2 Transducer Factors

Access: SETUP > "Transducer" > "Edit Line" / "Copy Line" / "New Line"

The settings and functions available for individual transducer lines are described here.

For instructions on creating and editing transducer lines see chapter 3.8.3, "How to Configure the Transducer", on page 297.



Name....296
Comment....296
Unit....296
X-Axis Scaling....297
Data points....297
Insert Value....297
Delete Value....297
Shift x....297
Shift y....297
Save....297

Name
Defines the transducer line name. All names must be compatible with the Microsoft Windows conventions for file names. The transducer data is stored under this name (with a `.TDF` extension) in the `trd` subfolder of the main installation folder.

Remote command:
`[SENSe:]CORRection:TRANsducer:SELect` on page 601

Comment
Defines an optional comment for the transducer line. The text may contain up to 40 characters.

Remote command:
`[SENSe:]CORRection:TRANsducer:COMMent` on page 600

Unit
The unit in which the y-values of the data points of the transducer line are defined.

As soon as a transducer is activated, the unit of the transducer is automatically used for all the level settings and outputs. The unit cannot be changed in the amplitude settings unless dB is used.

Remote command:
`[SENSe:]CORRection:TRANsducer:UNIT` on page 602

X-Axis Scaling
Describes the scaling of the horizontal axis on which the data points of the transducer line are defined. Scaling can be linear or logarithmic.

Remote command:
`[SENSe:]CORRection:TRANsducer:SCALing` on page 601

Data points
Each transducer line is defined by a minimum of 2 and a maximum of 50 data points. Each data point is defined by its position (x-axis) and value (y-value).

The data points must comply with the following rules to ensure correct operation:

- The frequencies for the data points must always be defined in ascending order. Otherwise the entry will not be accepted and the an error message is displayed.
- The frequencies of the data points may exceed the valid frequency range of the R&S FSWP since only the set frequency range is taken into account for measurements. The minimum frequency of a data point is 0 Hz, the maximum frequency 200 GHz.
- The value range for the transducer factor is ±200 dB.
- Gain has to be entered as a negative value, and attenuation as a positive value.

Remote command:
`[SENSe:]CORRection:TRANsducer:DATA` on page 600

Insert Value
Inserts a data point in the transducer line above the selected one in the "Edit Transducer" dialog box.

Delete Value
Deletes the selected data point in the "Edit Transducer" dialog box.

Shift x
Shifts the x-value of each data point horizontally by the defined shift width.

Shift y
Shifts the y-value of each data point vertically by the defined shift width.

Save
Saves the currently edited transducer line under the name defined in the "Name" field.

Remote command:
`MMEMory:SELect[:ITEM]:TRANsducer:ALL` on page 600

3.8.3 How to Configure the Transducer

Configuring the transducer is very similar to configuring limit lines.

The transducer settings are defined in the "Transducer" dialog box which is displayed when you press the SETUP key and then select "Transducer".

Stored transducer settings

If a transducer file was in use when the save set was stored (with the save item "Current Settings" only) it is anticipated that these transducer values should remain valid after every recall of that save set. Thus, even if the transducer file is changed and the original save set file is recalled later, the *originally stored* transducer values are recalled and applied to the measurement. In the "Edit transducer" dialog box, however, the *changed* transducer file values are displayed as no updated transducer file was loaded.

For more information see the R&S FSWP User Manual.

The following tasks are described:

- "How to find compatible transducer lines" on page 298
- "How to activate and deactivate a transducer" on page 298
- "How to edit existing transducer lines" on page 298
- "How to copy an existing transducer line" on page 299
- "How to delete an existing transducer line" on page 299
- "How to configure a new transducer line" on page 299
- "How to move the transducer line vertically or horizontally" on page 300

How to find compatible transducer lines

► In the "Transducer" dialog box, select the "View filter" option: "Show compatible".

All transducer lines stored on the instrument that are compatible to the current measurement settings are displayed in the overview.

How to activate and deactivate a transducer

1. To activate a transducer select a transducer line in the overview and select the "Active" setting for it.

   The trace is automatically recalculated for the next sweep after a transducer line is activated.

2. To deactivate a transducer line, deactivate the "Active" setting for it.

   After the next sweep, the originally measured values are displayed.

How to edit existing transducer lines

Existing transducer line configurations can be edited.

1. In the "Transducer" dialog box, select the transducer line.
2. Select the "Edit" button.
3. Edit the line configuration as described in "How to configure a new transducer line" on page 299.

4. Save the new configuration by selecting the "Save" button.

   The trace is automatically recalculated for the next sweep if the transducer line is active.

In order to store the changes to the transducer lines in a settings file, select the "Save" icon in the toolbar.

How to copy an existing transducer line

1. In the "Transducer" dialog box, select the transducer line.
2. Select the "Copy" button.

   The "Edit Transducer" dialog box is opened with the configuration of the selected transducer.
3. Define a new name to create a new transducer with the same configuration as the source line.
4. Edit the line configuration as described in "How to configure a new transducer line" on page 299.
5. Save the new configuration by selecting the "Save" button.

   The new transducer line is displayed in the overview and can be activated.

How to delete an existing transducer line

1. In the "Transducer" dialog box, select the transducer line.
2. Select the "Delete" button.
3. Confirm the message.

   The transducer line is deleted. After the next sweep, the originally measured values are displayed.

How to configure a new transducer line

1. In the "Transducer" dialog box, select the "New" button.

   The "Edit Transducer" dialog box is displayed. The current line configuration is displayed in the preview area of the dialog box. The preview is updated after each change to the configuration.
2. Define a "Name" and, optionally, a "Comment" for the new transducer line.
3. Define the scaling for the x-axis.
4. Define the data points: minimum 2, maximum 1000:
   a) Select "Insert Value".
   b) Define the x-value ("Position") and y-value ("Value") of the first data point.
   c) Select "Insert Value" again and define the second data point.

d) Repeat this to insert all other data points.
To insert a data point before an existing one, select the data point and then "Insert Value".
To insert a new data point at the end of the list, move the focus to the line after the last entry and then select "Insert Value".
To delete a data point, select the entry and then "Delete Value".

5. Check the current line configuration in the preview area of the dialog box. If necessary, correct individual data points or add or delete some.
If necessary, shift the entire line vertically or horizontally by selecting the "Shift x" or "Shift y" button and defining the shift width.
6. Save the new configuration by selecting the "Save" button.

   The new transducer line is displayed in the overview and can be activated.

How to move the transducer line vertically or horizontally

A configured transducer line can easily be moved vertically or horizontally. Thus, a new transducer line can be easily generated based upon an existing transducer line which has been shifted.

1. In the "Line Config" dialog box, select the transducer line.
2. Select the "Edit" button.
3. In the "Edit transducer Line" dialog box, select the "Shift x" or "Shift y" button and define the shift width.
4. Save the shifted data points by selecting the "Save" button.

   If activated, the trace is recalculated after the next sweep.

4 Common Analysis and Display Functions

General methods and basic settings to display and analyze measurements, regardless of the operating mode, are described here. If you are performing a specific measurement task, using an operating mode other than Signal and Spectrum Analyzer mode, or an application other than the Spectrum application, be sure to check the specific application or mode description for settings and functions that may deviate from these common settings.

The analysis settings and functions are available via the "Analysis" dialog box, which is displayed when you select the "Analysis" button in the "Overview". Additional measurement- specific analysis functions may be available in separate tabs in the "Analysis" dialog box. These are described with the individual measurements.

- Result Display Configuration....301
- Zoomed Displays....308
- Configuring Traces....313
- Marker Usage....347
- Display and Limit Lines....381

4.1 Result Display Configuration

Measurement results can be evaluated in many different ways, for example graphically, as summary tables, statistical evaluations etc. Thus, the result display is highly configurable to suit your specific requirements and optimize analysis. Here you can find out how to optimize the display for your measurement results.

Basic operations concerning the R&S FSWP display, for example how to use the SmartGrid, are described in the R&S FSWP Getting Started manual.

General display settings that are usually configured during initial instrument setup, independently of the current measurement, e.g. which items or colors are displayed on the screen, are described in the R&S FSWP User Manual.

- Basic Evaluation Methods....301
- Laying out the Result Display with the SmartGrid....304

4.1.1 Basic Evaluation Methods

Measurement results can be displayed and evaluated using various different methods, also at the same time. Depending on the currently selected measurement, in particular when using optional firmware applications, not all evaluation methods are available.

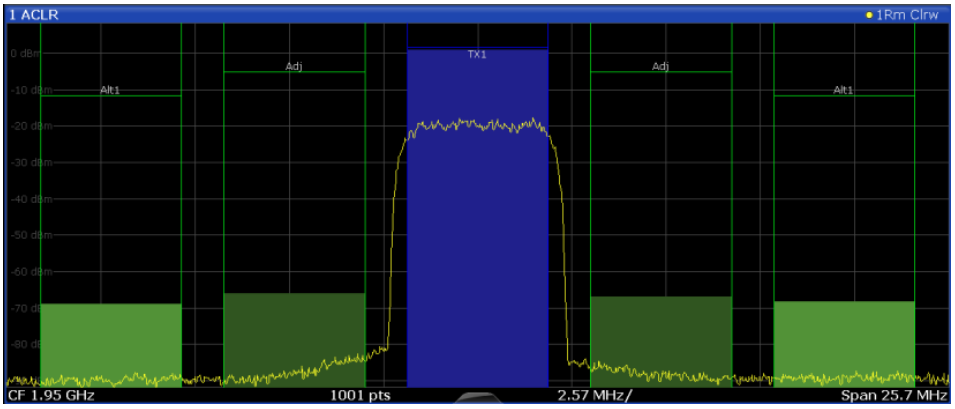
The evaluation methods described here are available for most measurements in the Spectrum application.

Diagram....302
Marker Table....302
Marker Peak List....303
Result Summary....303
Spectrogram....303

Diagram

Displays a basic level vs. frequency or level vs. time diagram of the measured data to evaluate the results graphically. This is the default evaluation method. Which data is displayed in the diagram depends on the "Trace" settings. Scaling for the y-axis can be configured.

More information



Remote command:

`LAY:ADD? '1',RIGH, DIAG`, see `LAYout:ADD[:WINDow]?` on page 537

Marker Table

Displays a table with the current marker values for the active markers.

This table may be displayed automatically if configured accordingly.

Type	Shows the marker type and number ("M" for a normal marker, "D" for a delta marker).
Ref	Shows the reference marker a delta marker refers to.
Trace	Shows the trace the marker is positioned on.
X- / Y-Value	Shows the marker coordinates (usually frequency and level).

Tip: To navigate within long marker tables, simply scroll through the entries with your finger on the touchscreen.

Remote command:

`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 537

Results:

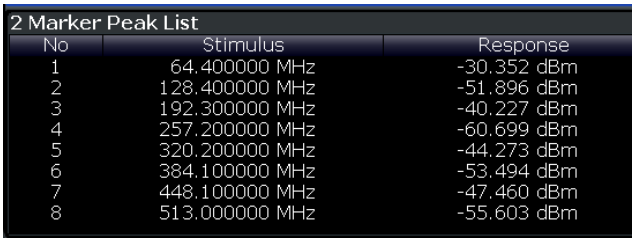
`CALCulate<n>:MARKer<m>:X` on page 627

`CALCulate<n>:MARKer<m>:Y?` on page 639

Marker Peak List
The marker peak list determines the frequencies and levels of peaks in the spectrum or time domain. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.

You can define search and sort criteria to influence the results of the analysis

More information



Tip: To navigate within long marker peak lists, simply scroll through the entries with your finger on the touchscreen.

Remote command:
`LAY:ADD? '1',RIGH, PEAK`, see `LAYout:ADD[:WINDow]?` on page 537
Results:
`CALCulate<n>:MARKer<m>:X` on page 627
`CALCulate<n>:MARKer<m>:Y?` on page 639

Result Summary
Result summaries provide the results of specific measurement functions in a table for numerical evaluation. The contents of the result summary vary depending on the selected measurement function. See the description of the individual measurement functions for details.

2 Result Summary
Channel Bandwidth Offset Power
TX1 (Ref) 1.229 MHz -0.86 dBm
Tx Total -0.86 dBm
Channel Bandwidth Offset Lower Upper
Adj 30.000 kHz 750.000 kHz -79.59 dB -80.34 dB
Alt1 30.000 kHz 1.980 MHz -85.04 dB -83.85 dB

Tip: To navigate within long result summary tables, simply scroll through the entries with your finger on the touchscreen.

Remote command:
`LAY:ADD? '1',RIGH, RSUM`, see `LAYout:ADD[:WINDow]?` on page 537

Spectrogram
A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency or sweep time, the y-axis shows the measurement time. A third dimension, the power level, is indicated by different colors. Thus you can see how the strength of the signal varies over time for different frequencies.

The spectrogram display consists of two diagrams: the standard spectrum result display (upper diagram) and the spectrogram result display (lower diagram).

For details see chapter 4.3.1.7, "Working with Spectrograms", on page 320.

Remote command:
`LAY:ADD? '1',RIGH, SGR`, see `LAYout:ADD[:WINDow]?` on page 537

4.1.2 Laying out the Result Display with the SmartGrid

Measurement results can be evaluated in many different ways, for example graphically, as summary tables, statistical evaluations etc. Each type of evaluation is displayed in a separate window in the channel tab. Up to 16 individual windows can be displayed per measurement channel (i.e. per tab). To arrange the diagrams and tables on the screen, the Rohde & Schwarz SmartGrid function helps you find the target position simply and quickly.

(For details on evaluation methods see the User Manual.)

Principally, the layout of the windows on the screen is based on an underlying grid, the SmartGrid. However, the SmartGrid is dynamic and flexible, allowing for many different layout possibilities. The SmartGrid functionality provides the following basic features:

- Windows can be arranged in columns or in rows, or in a combination of both.
- Windows can be arranged in up to four rows and four columns.
- Windows are moved simply by dragging them to a new position on the screen, possibly changing the layout of the other windows, as well.
- All evaluation methods available for the currently selected measurement are displayed as icons in the evaluation bar. If the evaluation bar contains more icons than can be displayed at once on the screen, it can be scrolled vertically. The same evaluation method can be displayed in multiple windows simultaneously.
- New windows are added by dragging an evaluation icon from the evaluation bar to the screen. The position of each new window depends on where you drop the evaluation icon in relation to the existing windows.
- All display configuration actions are only possible in SmartGrid mode. When SmartGrid mode is activated, the evaluation bar replaces the current softkey menu display. When the SmartGrid mode is deactivated again, the previous softkey menu display is restored.

- Background Information: The SmartGrid Principle.....304
- How to Activate SmartGrid Mode.....306
- How to Add a New Result Window..... 306
- How to Close a Result Window.....307
- How to Arrange the Result Windows..... 307

4.1.2.1 Background Information: The SmartGrid Principle

SmartGrid display

During any positioning action, the underlying SmartGrid is displayed. Different colors and frames indicate the possible new positions. The position in the SmartGrid where you drop the window determines its position on the screen.

Fig. 4-1: Moving a window in SmartGrid mode

The brown area indicates the possible "drop area" for the window, i.e. the area in which the window can be placed. A blue area indicates the (approximate) layout of the window as it would be if the icon were dropped at the current position. The frames indicate the possible destinations of the new window with respect to the existing windows: above/below, right/left or replacement (as illustrated in figure 4-2). If an existing window would be replaced, the drop area is highlighted in a darker color shade.

Positioning the window

The screen can be divided into up to four rows. Each row can be split into up to four columns, where each row can have a different number of columns. However, rows always span the entire width of the screen and may not be interrupted by a column. A single row is available as the drop area for the window in the SmartGrid. The row can be split into columns, or a new row can be inserted above or below the existing row (if the maximum of 4 has not yet been reached).

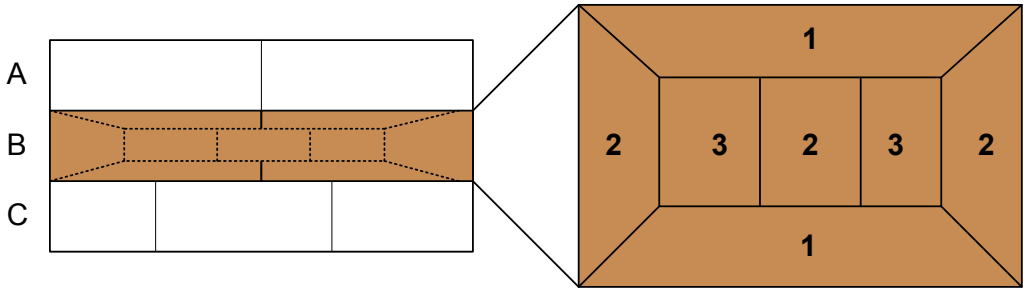


Fig. 4-2: SmartGrid window positions

1 = Insert row above or below the existing row
2 = Create a new column in the existing row
3 = Replace a window in the existing row

SmartGrid functions

Once the evaluation icon has been dropped, icons in each window provide delete and move functions.

The "Move" icon allows you to move the position of the window, possibly changing the size and position of the other displayed windows.

The "Delete" icon allows you to close the window, enlarging the display of the remaining windows.

4.1.2.2 How to Activate SmartGrid Mode

All display configuration actions are only possible in SmartGrid mode. In SmartGrid mode the evaluation bar replaces the current softkey menu display. When the SmartGrid mode is deactivated again, the previous softkey menu display is restored.

► To activate SmartGrid mode, do one of the following:

-

  Select the "SmartGrid" icon from the toolbar.
- Select the "Display Config" button in the configuration "Overview".
- Select the "Display Config" softkey from the MEAS CONFIG menu.

The SmartGrid functions and the evaluation bar are displayed.

To close the SmartGrid mode and restore the previous softkey menu select the "Close" icon in the right-hand corner of the toolbar, or press any key.

4.1.2.3 How to Add a New Result Window

Each type of evaluation is displayed in a separate window. Up to 16 individual windows can be displayed per measurement channel (i.e. per tab).

1. Activate SmartGrid mode.

   All evaluation methods available for the currently selected measurement are displayed as icons in the evaluation bar.

2. Select the icon for the required evaluation method from the evaluation bar.
   If the evaluation bar contains more icons than can be displayed at once on the screen, it can be scrolled vertically. Touch the evaluation bar between the icons and move it up or down until the required icon appears.

3. Drag the required icon from the evaluation bar to the SmartGrid, which is displayed in the diagram area, and drop it at the required position. (See chapter 4.1.2.5, "How to Arrange the Result Windows", on page 307 for more information on positioning the window).

Remote command:

LAYout:ADD[:WINDow]? on page 537 / LAYout:WINDow<n>:ADD? on page 542

4.1.2.4 How to Close a Result Window

► To close a window, activate SmartGrid mode and select the "Delete" icon for the window.

Remote command:

LAYout:REMove[:WINDow] on page 539 / LAYout:WINDow<n>:REMove on page 542

4.1.2.5 How to Arrange the Result Windows

1. Select an icon from the evaluation bar or the "Move" icon for an existing evaluation window.

2. Drag the evaluation over the SmartGrid.
   A blue area shows where the window will be placed.
3. Move the window until a suitable area is indicated in blue.
4. Drop the window in the target area.

   The windows are rearranged to the selected layout, and "Delete" and "Move" icons are displayed in each window.
5. To close a window, select the corresponding "Delete" icon.

Remote command:

LAYout:REPLace[:WINDow] on page 540 / LAYout:WINDow<n>:REPLace on page 543

4.2 Zoomed Displays

You can zoom into the diagram to visualize the measurement results in greater detail. Using the touchscreen or a mouse pointer you can easily define the area to be enlarged.

Zoom and the number of sweep points

Note that zooming is merely a visual tool, it does not change any measurement settings, such as the number of sweep points!

You should increase the number of sweep points before zooming, as otherwise the function has no real effect (see chapter 3.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 260).

- Single Zoom Versus Multiple Zoom 308
- Zoom Functions 310
- How to Zoom Into a Diagram 311

4.2.1 Single Zoom Versus Multiple Zoom

Two different (graphical) zoom modes are available: single zoom and multiple zoom. A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. This function can be used repetitively until the required details are visible. In multiple zoom mode, you can enlarge up to four different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace, while the zoomed trace areas are displayed in individual windows. The zoom areas can be moved and resized any time. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.

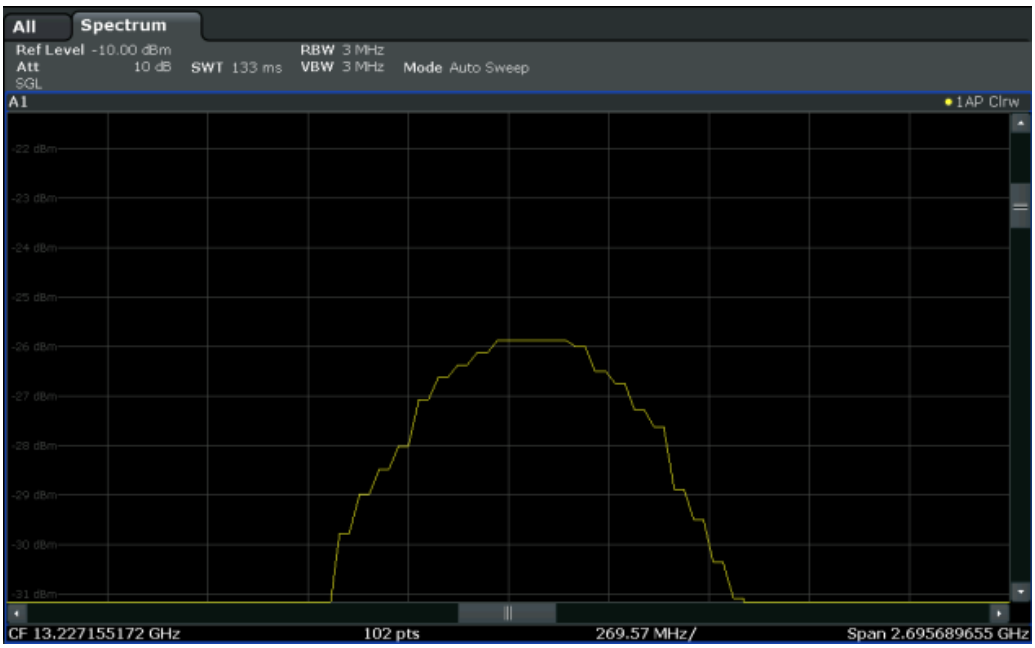


Fig. 4-3: Single zoom

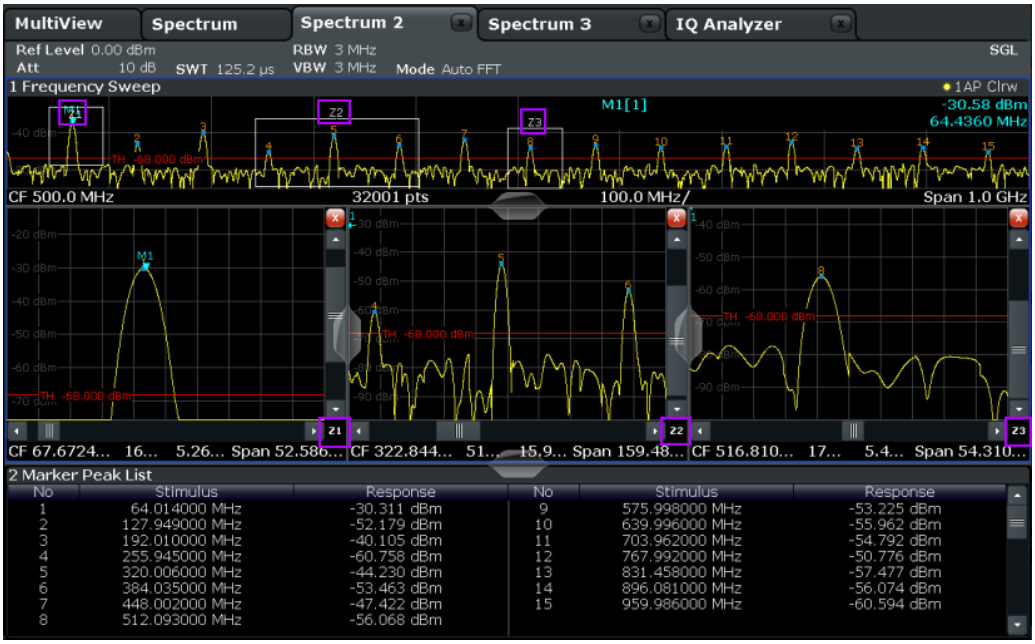


Fig. 4-4: Multiple zoom

Using the zoom area to restrict a peak search

The selected zoom area can be used to restrict the search range for a peak search, but only in single zoom mode (see "Using Zoom Limits" on page 366).

4.2.2 Zoom Functions

The zoom functions are only available from the toolbar.

Single Zoom....310
Multiple Zoom....310
Restore Original Display....310
Deactivating Zoom (Selection mode)....310

Single Zoom

A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. This function can be used repetitively until the required details are visible.

Remote command:
`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 604
`DISPlay[:WINDow<n>]:ZOOM:AREA` on page 603

Multiple Zoom

In multiple zoom mode, you can enlarge several different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace, while the zoomed trace areas are displayed in individual windows. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.

Remote command:
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 604
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA` on page 603

Restore Original Display

Restores the original display, that is, the originally calculated displays for the entire capture buffer, and closes all zoom windows.

Remote command:
single zoom:
`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 604
multiple zoom:
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 604 (for each multiple zoom window)

Deactivating Zoom (Selection mode)
Deactivates any zoom mode.

Tapping the screen no longer invokes a zoom, but selects an object.

Remote command:
single zoom:
`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 604
multiple zoom:
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 604 (for each multiple zoom window)

4.2.3 How to Zoom Into a Diagram

The remote commands required to zoom into a display are described in chapter 5.8.1, "Zoom", on page 603.

The following tasks are described here:

- "To zoom into the diagram at one position" on page 311
- "To return to selection mode in the diagram" on page 312
- "To return to original display" on page 312
- "To zoom into multiple positions in the diagram" on page 312

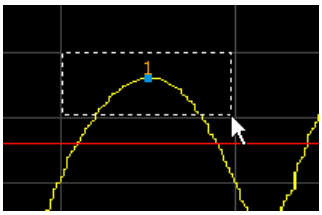
To zoom into the diagram at one position

1.

   Click on the "Single Zoom" icon in the toolbar.

   Zoom mode is activated.

2. Select the area in the diagram to be enlarged on the touchscreen. The selected area is indicated by a dotted rectangle.

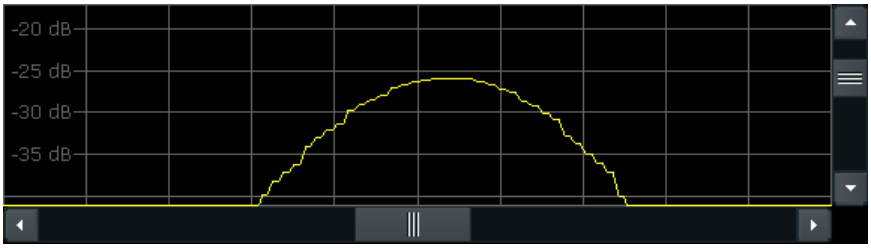
   

   When you leave the touchscreen, the diagram is replaced by the zoomed trace area.

3. Repeat these steps, if necessary, to enlarge the diagram further.

Scrolling in the zoomed display

You can scroll the diagram area to display the entire diagram using the scrollbars at the right and at the bottom of the diagram.



To return to selection mode in the diagram

While you are in zoom mode, touching the screen changes the zoom area. In order to select or move a trace or marker, you must switch back to selection mode:

▶

Select the "Selection mode" icon in the toolbar.

To return to original display

▶

Click on the "Zoom Off" icon in the toolbar.

The original trace display is restored. Zoom mode remains active, however.
To switch off zoom mode and return to selection mode, select the "Selection mode" icon in the toolbar.

To zoom into multiple positions in the diagram

1.

   Click on the "Multiple Zoom" icon in the toolbar.

   Multiple zoom mode is activated.

2. Select the first area in the diagram to be enlarged as described in "To zoom into the diagram at one position" on page 311. The selected area is indicated by a dotted rectangle.

   When you have completed your selection, the original trace is shown in an overview diagram with the selected area indicated by a dotted rectangle. The zoomed trace area is displayed in a separate window (see figure 4-4.

3. In the overview diagram, select the next area to be enlarged.

   The second zoom area is indicated in the overview diagram, and a second zoom window is displayed.

4. Repeat these steps, if necessary, to zoom into further trace areas (up to four).

To move or change zoom areas

In multiple zoom mode, you can change the size or position of the individual zoom areas easily at any time.

1. If necessary, switch off zoom mode and return to selection mode by selecting the "Selection mode" icon in the toolbar.
2. To resize a zoom area, tap directly **on** the corresponding frame in the overview window and drag the line to change the size of the frame.
   To move a zoom area, tap **inside** the corresponding frame in the overview window and drag the frame to the new position.

   The contents of the zoom windows are adapted accordingly.

4.3 Configuring Traces

A trace is a collection of measured data points. The trace settings determine how the measured data is analyzed and displayed on the screen.

- Basic Information about Traces 313
- Trace Configuration 326
- How to Configure a Standard Trace 337
- How to Export Trace Data and Numerical Results 338
- How to Display and Configure a Spectrogram 339
- Reference: ASCII File Export Format 343
- Formats for Returned Values: ASCII Format and Binary Format 347

4.3.1 Basic Information about Traces

Some background knowledge on traces is provided here for a better understanding of the required configuration settings.

- Mapping Samples to measurement Points with the Trace Detector 313
- Analyzing Several Traces - Trace Mode 316
- How Many Traces are Averaged - Sweep Count + Measurement Mode 317
- How Trace Data is Averaged - the Averaging Mode 318
- Trace Mathematics 319
- Trace Smoothing 319
- Working with Spectrograms 320

4.3.1.1 Mapping Samples to measurement Points with the Trace Detector

A trace displays the values measured at the measurement points. The number of samples taken during a measurement may be much larger than the number of measurement points that are displayed in the measurement trace.

Example:

Assume the following measurement parameters:

- Sample rate: 32 MSamples / s
- measurement points: 1000
- measurement time: 100 ms
- Span: 5 GHz

During a single measurement, 3.2 * 10^6 samples are collected and distributed to 1000 measurement points, i.e. 3200 samples are collected per measurement point. For each measurement point, the measured data for a frequency span of 5 MHz (span/<measurement points>) is analyzed.

Note that if you increase the number of measurement points, the frequency span analyzed for each point in the trace decreases, making the result more stable.

See also chapter 3.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 260.

Obviously, a data reduction must be performed to determine which of the samples are displayed for each measurement point. This is the trace detector's task.

The trace detector can analyze the measured data using various methods:

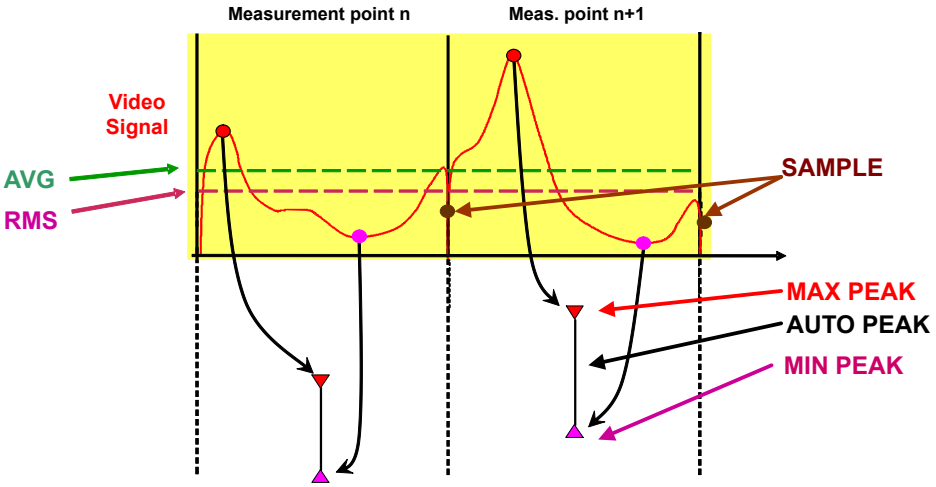
The detector activated for the specific trace is indicated in the corresponding trace information by an abbreviation.

Table 4-1: Detector types

Detector	Abbrev.	Description
Positive Peak	Pk	Determines the largest of all positive peak values of the levels measured at the individual frequencies which are displayed in one sample point
Negative Peak	Mi	Determines the smallest of all negative peak values of the levels measured at the individual frequencies which are displayed in one sample point
Auto Peak	Ap	Combines the peak detectors; determines the maximum and the minimum value of the levels measured at the individual frequencies which are displayed in one sample point (not available for SEM)
RMS	Rm	Calculates the root mean square of all samples contained in a measurement point. To this effect, R&S FSWP uses the linear voltage after envelope detection. The sampled linear values are squared, summed and the sum is divided by the number of samples (= root mean square). For logarithmic display the logarithm is formed from the square sum. For linear display the root mean square value is displayed. Each measurement point thus corresponds to the power of the measured values summed up in the measurement point. The RMS detector supplies the power of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal). Correction factors as needed for other detectors to measure the power of the different signal classes are not required.

Detector	Abbrev.	Description
Average	Av	Calculates the linear average of all samples contained in a measurement point. To this effect, R&S FSWP uses the linear voltage after envelope detection. The sampled linear values are summed up and the sum is divided by the number of samples (= linear average value). For logarithmic display the logarithm is formed from the average value. For linear display the average value is displayed. Each measurement point thus corresponds to the average of the measured values summed up in the measurement point. The average detector supplies the average value of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal).
Sample	Sa	Selects the last measured value of the levels measured at the individual frequencies which are displayed in one sample point; all other measured values for the frequency range are ignored

The result obtained from the selected detector for a measurement point is displayed as the value at this frequency point in the trace.



The trace detector for the individual traces can be selected manually by the user or set automatically by the R&S FSWP.

The detectors of the R&S FSWP are implemented as pure digital devices. All detectors work in parallel in the background, which means that the measurement speed is independent of the detector combination used for different traces.

RMS detector and VBW

If the RMS detector is selected, the video bandwidth in the hardware is bypassed. Thus, duplicate trace averaging with small VBWs and RMS detector no longer occurs. However, the VBW is still considered when calculating the sweep time. This leads to a longer sweep time for small VBW values. Thus, you can reduce the VBW value to achieve more stable trace curves even when using an RMS detector. Normally, if the RMS detector is used the sweep time should be increased to get more stable traces.

Auto detector

If the R&S FSWP is set to define the appropriate detector automatically, the detector is set depending on the selected trace mode:

Trace mode	Detector
Clear Write	Auto Peak
Max Hold	Positive Peak
Min Hold	Negative Peak
Average	Sample Peak
View	–
Blank	–

4.3.1.2 Analyzing Several Traces - Trace Mode

If several measurement are performed one after the other, or continuous measurement are performed, the trace mode determines how the data for subsequent traces is processed. After each measurement, the trace mode determines whether:

- the data is frozen (View)
- the data is hidden (Blank)
- the data is replaced by new values (Clear Write)
- the data is replaced selectively (Max Hold, Min Hold, Average)

Each time the trace mode is changed, the selected trace memory is cleared.

The trace mode also determines the detector type if the detector is set automatically, see chapter 4.3.1.1, "Mapping Samples to measurement Points with the Trace Detector", on page 313.

The R&S FSWP supports the following trace modes:

Table 4-2: Overview of available trace modes

Trace Mode	Description
Blank	Hides the selected trace.
Clear Write	Overwrite mode: the trace is overwritten by each measurement. This is the default setting. All available detectors can be selected.
Max Hold	The maximum value is determined over several measurements and displayed. The R&S FSWP saves the measurement result in the trace memory only if the new value is greater than the previous one. This mode is especially useful with modulated or pulsed signals. The signal spectrum is filled up upon each measurement until all signal components are detected in a kind of envelope. This mode is not available for statistics measurements.

Trace Mode	Description
Min Hold	The minimum value is determined from several measurements and displayed. The R&S FSWP saves the measurement result in the trace memory only if the new value is lower than the previous one. This mode is useful for example for making an unmodulated carrier in a composite signal visible. Noise, interference signals or modulated signals are suppressed, whereas a CW signal is recognized by its constant level. This mode is not available for statistics measurements.
Average	The average is formed over several measurements and displayed. The Sweep / Average Count determines the number of averaging procedures. This mode is not available for statistics measurements.
View	The current contents of the trace memory are frozen and displayed.

If a trace is frozen ("View" mode), the measurement settings, apart from scaling settings, can be changed without impact on the displayed trace. The fact that the displayed trace no longer matches the current measurement settings is indicated by a yellow asterisk on the tab label.

If you change any parameters that have an effect on the scaling of the diagram axes, the R&S FSWP automatically adapts the trace data to the changed display range. This allows you to zoom into the diagram after the measurement in order to show details of the trace.

4.3.1.3 How Many Traces are Averaged - Sweep Count + Measurement Mode

In "Average" trace mode, the sweep count and measurement mode determine how many traces are averaged. The more traces are averaged, the smoother the trace is likely to become.

The algorithm for averaging traces depends on the measurement mode and sweep count.

- **sweep count = 0** (default)
  - In **"Continuous"** measurement mode, a continuous average is calculated for 10 measurements, according to the following formula:

$$Trace = \frac{9 * Trace_{old} + MeasValue}{10}$$

Fig. 4-5: Equation 1

Due to the weighting between the current trace and the average trace, past values have practically no influence on the displayed trace after about ten measurements. With this setting, signal noise is effectively reduced without need for restarting the averaging process after a change of the signal.

  - In **"Single"** measurement mode, the current trace is averaged with the previously stored averaged trace. No averaging is carried out for the first measurement but the measured value is stored in the trace memory. The next time a

measurement is performed, the trace average is calculated according to the following formula:

$$Trace = \frac{Trace_{old} + MeasValue}{2}$$

The averaged trace is then stored in the trace memory.

- **sweep count = 1**
  The currently measured trace is displayed and stored in the trace memory. No averaging is performed.
- **sweep count > 1**
  For both **"Single"** measurement mode and **"Continuous"** measurement mode, averaging takes place over the selected number of measurements. In this case the displayed trace is determined during averaging according to the following formula:

$$Trace_n = \frac{1}{n} \cdot \left[\sum_{i=1}^{n-1} (T_i) + MeasValue_n \right]$$

Fig. 4-6: Equation 2

where n is the number of the current measurement (n = 2 ... Sweep Count).
No averaging is carried out for the first measurement but the measured value is stored in the trace memory. With increasing n, the displayed trace is increasingly smoothed since there are more individual measurements for averaging.
After the selected number of measurements the average trace is saved in the trace memory. Until this number of measurements is reached, a preliminary average is displayed. When the averaging length defined by the "Sweep Count" is attained, averaging is continued in continuous measurement mode or for "Continue Single Measurement" according to the following formula:

$$Trace = \frac{(N-1) * Trace_{old} + MeasValue}{N}$$

where N is the sweep count

4.3.1.4 How Trace Data is Averaged - the Averaging Mode

When the trace is averaged over several sweeps (Trace mode: "Average"), different methods are available to determine the trace average.

With logarithmic averaging, the dB values of the display voltage are averaged or substracted from each other with trace mathematical functions.

With linear averaging, the level values in dB are converted into linear voltages or powers prior to averaging. Voltage or power values are averaged or offset against each other and reconverted into level values.

For stationary signals the two methods yield the same result.

Logarithmic averaging is recommended if sinewave signals are to be clearly visible against noise since with this type of averaging noise suppression is improved while the sinewave signals remain unchanged.

For noise or pseudo-noise signals the positive peak amplitudes are decreased in logarithmic averaging due to the characteristic involved and the negative peak values are increased relative to the average value. If the distorted amplitude distribution is averaged, a value is obtained that is smaller than the actual average value. The difference is -2.5 dB.

This low average value is usually corrected in noise power measurements by a 2.5 dB factor. Therefore the R&S FSWP offers the selection of linear averaging. The trace data is linearized prior to averaging, then averaged and logarithmized again for display on the screen. The average value is always displayed correctly irrespective of the signal characteristic.

4.3.1.5 Trace Mathematics

If you have several traces with different modes, for example an average trace and a maximum trace, it may be of interest to compare the results of both traces. In this example, you could analyze the maximum difference between the average and maximum values. To analyze the span of result values, you could subtract the minimum trace from the maximum trace. For such tasks, mathematical functions on trace results are provided.

4.3.1.6 Trace Smoothing

A Video Bandwidth Filter (VBW) is a hardware-based method of smoothing the trace (see also chapter 3.5.1.2, "Smoothing the Trace Using the Video Bandwidth", on page 256). However, other sweep and bandwidth settings may be coupled to the VBW, and for some signals, a VBW may not be freely selectable to obtain the required smoothing effect. Therefore, a software-based trace smoothing function is also available.

(Software-based) **smoothing** is a way to visually remove anomalies in the trace that may distort the results. The smoothing process is based on a moving average over the complete measurement range. The number of samples included in the averaging process (the *aperture* size) is variable and is a percentage of all samples that the trace consists of.

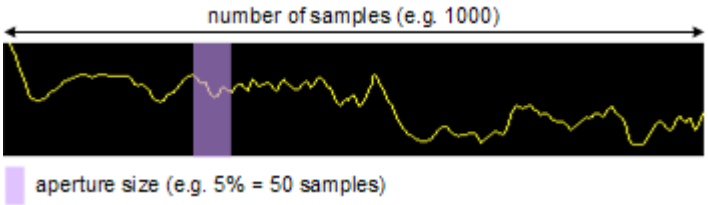


Fig. 4-7: Sample size included in trace smoothing

Effects of smoothing on post-processing functions

Note that in Spectrum mode, all functions performed after the sweep, such as limit checks, markers, or channel power measurements, are based on the smoothed trace data. Thus, the results will differ from results based on the original trace.

You can turn trace smoothing on and off for all traces individually and compare, for example, the raw and the smooth trace.

Linear smoothing is based on the following algorithm:

$$y'(s) = \frac{1}{n}\left(\sum_{x=s-\frac{n-1}{2}}^{x=s+\frac{n-1}{2}} y(x)\right)$$

Linear trace smoothing (4 - 1)

with:

s = sample number

x = sample offset from s

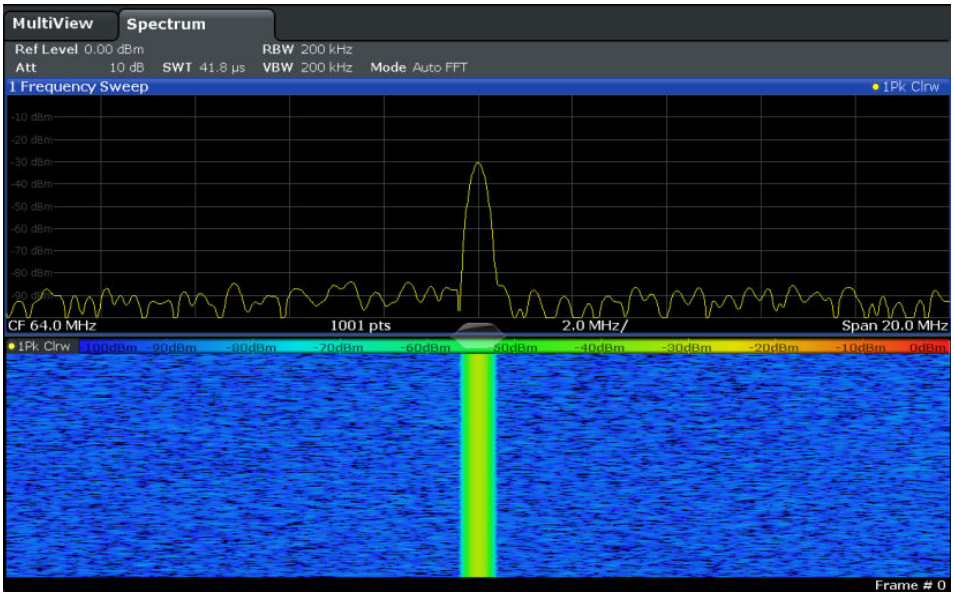
n = aperture size

4.3.1.7 Working with Spectrograms

In addition to the standard "level versus frequency" or "level versus time" traces, the R&S FSWP also provides a spectrogram display of the measured data.

A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency, the y-axis shows the time. A third dimension, the power level, is indicated by different colors. Thus you can see how the strength of the signal varies over time for different frequencies.

Example:



In this example you see the spectrogram for the calibration signal of the R&S FSWP, compared to the standard spectrum display. Since the signal does not change over time, the color of the frequency levels does not change over time, i.e. vertically. The legend above the spectrogram display describes the power levels the colors represent.

Result display

The spectrogram result can consist of the following elements:

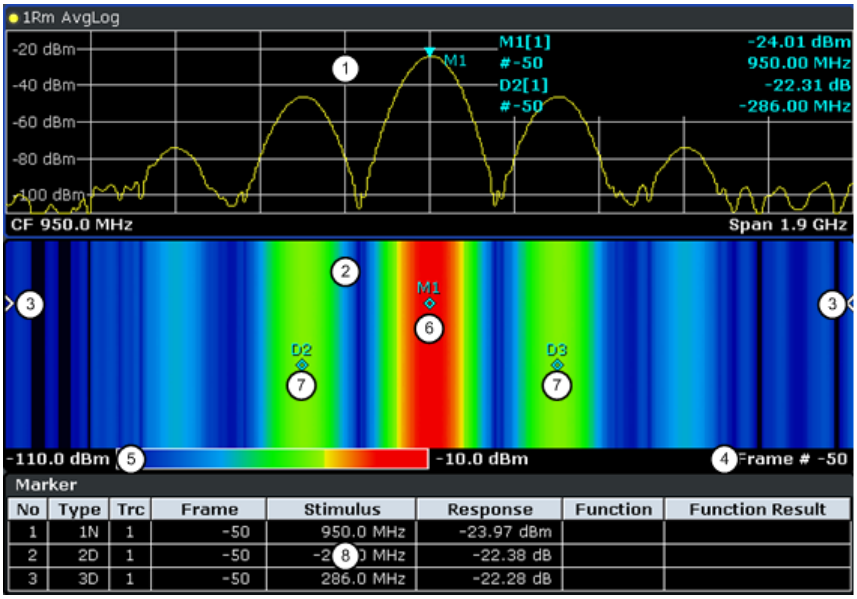


Fig. 4-8: Screen layout of the spectrogram result display

1 = Spectrum result display
2 = Spectrogram result display
3 = Current frame indicator
4 = Timestamp / frame number
5 = Color map
6 = Marker
7 = Delta marker
8 = Marker list

For more information about spectrogram configuration see chapter 4.3.2.4, "Spectrogram Settings", on page 333.

Remote commands:

Activating and configuring spectrograms:

chapter 5.8.2.5, "Configuring Spectrograms", on page 616

Storing results:

`MMEMory:STORe<n>:SPECtrogram` on page 622

- Time Frames.....321
- Color Maps.....323
- Markers in the Spectrogram.....325

Time Frames

The time information in the spectrogram is displayed vertically, along the y-axis. Each line (or trace) of the y-axis represents one or more captured measurement and is called a **time frame** or simply "frame". As with standard spectrum traces, several measured values are combined in one measurement point using the selected detector.

(See chapter 4.3.1.1, "Mapping Samples to measurement Points with the Trace Detector", on page 313).

Frames are sorted in chronological order, beginning with the most recently recorded frame at the top of the diagram (frame number 0). With the next measurement, the previous frame is moved further down in the diagram, until the maximum number of captured frames is reached. The display is updated continuously during the measurement, and the measured trace data is stored. Spectrogram displays are continued even after single measurements unless they are cleared manually.

The maximum number of frames that you can capture depends on the number of measurement points that are analyzed during the measurement.

The scaling of the time axis (y-axis) is not configurable. However, you can enlarge the spectrogram display by maximizing the window using the "Split/Maximize" key.

Frame analysis in the Spectrum application - Frame count vs. sweep count

As described for standard spectrum sweeps, the sweep count defines how many sweeps are analyzed to create a single trace. Thus, for a trace in "Average" mode, for example, a sweep count of 10 means that 10 sweeps are averaged to create a single trace, or frame.

The frame count, on the other hand, determines how many frames are plotted during a single sweep measurement (as opposed to a continuous sweep). For a frame count of 2, for example, 2 frames will be plotted during each single sweep. For continuous sweep mode, the frame count is irrelevant; one frame is plotted per sweep until the measurement is stopped.

If you combine the two settings, 20 sweeps will be performed for each single sweep measurement. The first 10 will be averaged to create the first frame, the next 10 will be averaged to create the second frame.

As you can see, increasing the sweep count increases the accuracy of the individual traces, while increasing the frame count increases the number of traces in the diagram.

Especially for "Average" or "Min hold" and "Max hold" trace modes, the number of sweeps that are analyzed to create a single trace has an effect on the accuracy of the results. Thus, you can also define whether the results from frames in previous traces are considered in the analysis for each new trace ("Continue frame").

Tracking absolute time - timestamps

Alternatively to the frame count, the absolute time (that is: a *timestamp*) at which a frame was captured can be displayed. While the measurement is running, the timestamp shows the system time. In single measurement mode or if the measurement is stopped, the timestamp shows the time and date at the end of the measurement.Thus, the individual frames can be identified by their timestamp or their frame count.

When active, the timestamp replaces the display of the frame number in the diagram footer (see figure 4-8).

Displaying individual frames

The spectrogram diagram contains all stored frames since it was last cleared. Arrows on the left and right border of the spectrogram indicate the currently selected frame. The spectrum diagram always displays the spectrum for the currently selected frame.

The current frame number is indicated in the diagram footer, or alternatively a time-stamp, if activated. The current frame, displayed at the top of the diagram, is frame number 0. Older frames further down in the diagram are indicated by a negative index, e.g."-10". You can display the spectrum diagram of a previous frame by changing the current frame number.

Color Maps

Spectrograms assign power levels to different colors in order to visualize them. The legend above the spectrogram display describes the power levels the colors represent.

The color display is highly configurable to adapt the spectrograms to your needs. You can define:

- Which colors to use (Color scheme)
- Which value range to apply the color scheme to
- How the colors are distributed within the value range, i.e where the focus of the visualization lies (shape of the color curve)

The individual colors are assigned to the power levels automatically by the R&S FSWP.

The Color Scheme

You can select which colors are assigned to the measured values. Four different color ranges or "schemes" are available:

- **Hot**

  Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.

- **Cold**

  Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.
  The "Cold" color scheme is the inverse "Hot" color scheme.

- **Radar**

  Uses a color range from black over green to light turquoise with shades of green in between. Dark colors indicate low levels, light colors indicate high ones.

- **Grayscale**

Shows the results in shades of gray. Dark gray indicates low levels, light gray indicates high ones.

The Value Range of the Color Map

If the measured values only cover a small area in the spectrogram, you can optimize the displayed value range so it becomes easier to distinguish between values that are close together, and only parts of interest are displayed at all.

The Shape and Focus of the Color Curve

The color mapping function assigns a specified color to a specified power level in the spectrogram display. By default, colors on the color map are distributed evenly. However, if a certain area of the value range is to be visualized in greater detail than the rest, you can set the focus of the color mapping to that area. Changing the focus is performed by changing the shape of the color curve.

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear. If you shift the curve to the left or right, the distribution becomes non-linear. The slope of the color curve increases or decreases. One end of the color palette then covers a large amount of results, while the other end distributes several colors over a relatively small result range.

You can use this feature to put the focus on a particular region in the diagram and to be able to detect small variations of the signal.

Example:

Fig. 4-9: Linear color curve shape = 0; colors are distributed evenly over the complete result range

In the color map based on the linear color curve, the range from -105.5 dBm to -60 dBm is covered by blue and a few shades of green only. The range from -60 dBm to -20 dBm is covered by red, yellow and a few shades of green.

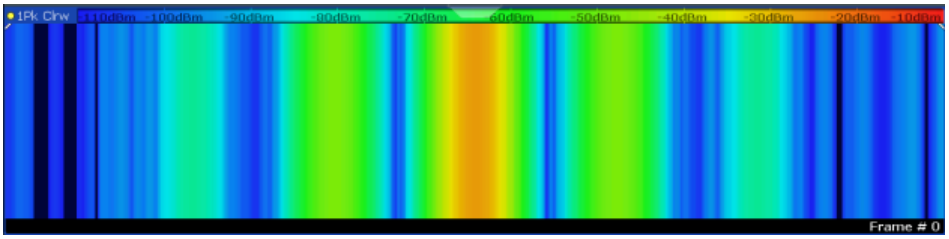


Fig. 4-10: Spectrogram with default color curve

The sample spectrogram is dominated by blue and green colors. After shifting the color curve to the left (negative value), more colors cover the range from -105.5 dBm to -60 dBm (blue, green and yellow), which occurs more often in the example. The range from -60 dBm to -20 dBm, on the other hand, is dominated by various shades of red only.

Fig. 4-11: Non-linear color curve shape = -0.5

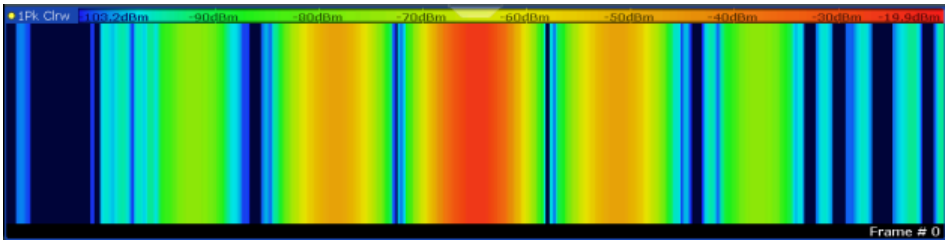
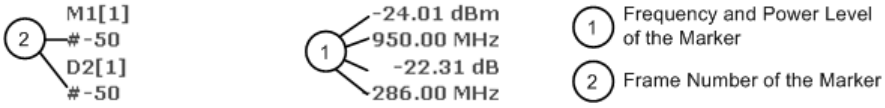


Fig. 4-12: Spectrogram with shifted color curve

Markers in the Spectrogram

Markers and delta markers are shaped like diamonds in the spectrogram. They are only displayed in the spectrogram if the marker position is inside the visible area of the spectrogram. If more than two markers are active, the marker values are displayed in a separate marker table.

In the spectrum result display, the markers and their frequency and level values (1) are displayed as usual. Additionally, the frame number is displayed to indicate the position of the marker in time (2).



In the spectrogram result display, you can activate up to 16 markers or delta markers at the same time. Each marker can be assigned to a different frame. Therefore, in addition to the frequency you also define the frame number when activating a new marker. If no frame number is specified, the marker is positioned on the currently selected frame. All markers are visible that are positioned on a visible frame. Special search functions are provided for spectrogram markers.

In the spectrum result display, only the markers positioned on the currently selected frame are visible. In "Continuous Sweep" mode this means that only markers positioned on frame 0 are visible. To view markers that are positioned on a frame other than frame 0 in the spectrum result display, you must stop the measurement and select the corresponding frame.

4.3.2 Trace Configuration

- Trace Settings....326
- Trace / Data Export Configuration....330
- Trace Math....332
- Spectrogram Settings....333
- How to Copy Traces....337

4.3.2.1 Trace Settings

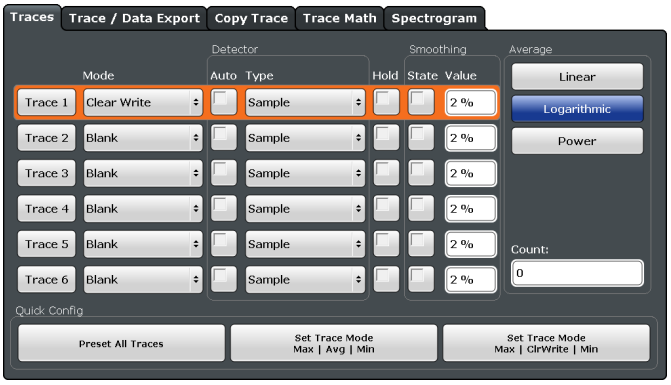
You can configure the settings for up to 6 individual traces.

The trace settings are configured in the "Traces" dialog box which is displayed when you do one of the following:

- Press the TRACE key, then select "Trace Config".
- In the "Overview", select "Analysis", then switch to the vertical "Traces" tab.

For settings on spectrograms, see chapter 4.3.2.4, "Spectrogram Settings", on page 333.

Trace data can also be exported to an ASCII file for further analysis. For details see chapter 4.3.2.2, "Trace / Data Export Configuration", on page 330.



Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6 327
Trace Mode 327
Detector 328
Hold 328
Smoothing 328
Average Mode 329
Average Count 329
Predefined Trace Settings - Quick Config 329
Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys) 330

Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6
Selects the corresponding trace for configuration. The currently selected trace is highlighted.

For details see chapter 4.3.3, "How to Configure a Standard Trace", on page 337.

Remote command:
Selected via numeric suffix of:`TRACe<1...6>` commands

Trace Mode
Defines the update mode for subsequent traces.

For details see chapter 4.3.1.2, "Analyzing Several Traces - Trace Mode", on page 316.

"Clear Write" Overwrite mode: the trace is overwritten by each measurement. This is the default setting.
The "Detector" is automatically set to "Auto Peak".

"Max Hold" The maximum value is determined over several measurements and displayed. The R&S FSWP saves each trace point in the trace memory only if the new value is greater than the previous one.
The "Detector" is automatically set to "Positive Peak".
This mode is not available for statistics measurements.

"Min Hold" The minimum value is determined from several measurements and displayed. The R&S FSWP saves each trace point in the trace memory only if the new value is lower than the previous one.
The "Detector" is automatically set to "Negative Peak".
This mode is not available for statistics measurements.

"Average" The average is formed over several measurements.
The Sweep / Average Count determines the number of averaging procedures.
The "Detector" is automatically set to "Sample".
This mode is not available for statistics measurements.

"View" The current contents of the trace memory are frozen and displayed.

"Blank" Removes the selected trace from the display.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 609

Detector
Defines the trace detector to be used for trace analysis.

For details see chapter 4.3.1.1, "Mapping Samples to measurement Points with the Trace Detector", on page 313.

"Auto" Selects the optimum detector for the selected trace and filter mode.
This is the default setting.

"Type" Defines the selected detector type.

Remote command:
`[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]` on page 608
`[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO` on page 608

Hold
If activated, traces in "Min Hold", "Max Hold" and "Average" mode are not reset after specific parameter changes have been made.

Normally, the measurement is started again after parameter changes, before the measurement results are analyzed (e.g. using a marker). In all cases that require a new measurement after parameter changes, the trace is reset automatically to avoid false results (e.g. with span changes). For applications that require no reset after parameter changes, the automatic reset can be switched off.

The default setting is off.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONtinuous` on page 610

Smoothing
If enabled, the trace is smoothed by the specified value (between 1 % and 50 %). The smoothing value is defined as a percentage of the display width. The larger the smoothing value, the greater the smoothing effect.

Note: Effects of smoothing on post-processing functions. Note that in Spectrum mode, all functions performed after the sweep, such as limit checks, markers, or channel power measurements, are based on the smoothed trace data. Thus, the results will differ from results based on the original trace.

For more information see chapter 4.3.1.6, "Trace Smoothing", on page 319.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe]` on page 611
`DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture` on page 609

Average Mode
Defines the mode with which the trace is averaged over several measurements. A different averaging mode can be defined for each trace.

This setting is only applicable if trace mode "Average" is selected.

How many measurements are averaged is defined by the "Sweep / Average Count" on page 265.

For details see chapter 4.3.1.4, "How Trace Data is Averaged - the Averaging Mode", on page 318.

"Linear" The power level values are converted into linear units prior to averaging. After the averaging, the data is converted back into its original unit.

"Logarithmic" For logarithmic scaling, the values are averaged in dBm. For linear scaling, the behavior is the same as with linear averaging.

"Power" Activates linear power averaging.
The power level values are converted into unit Watt prior to averaging. After the averaging, the data is converted back into its original unit.
Use this mode to average power values in Volts or Amperes correctly.

Remote command:
`[SENSe:]AVERage<n>:TYPE` on page 584

Average Count
Determines the number of averaging or maximum search procedures If the trace modes "Average", "Max Hold" or "Min Hold" are set.

In continuous measurement mode, if sweep count = 0 (default), averaging is performed over 10 measurements. For sweep count =1, no averaging, maxhold or minhold operations are performed.

This value is identical to the Sweep / Average Count setting in the "Sweep" settings.

Remote command:
`[SENSe:]AVERage<n>:COUNt` on page 584

Predefined Trace Settings - Quick Config
Commonly required trace settings have been predefined and can be applied very quickly by selecting the appropriate button.

Function	Trace Settings	
Preset All Traces	Trace 1:	Clear Write Auto Detector (Auto Peak)
	Traces 2-6:	Blank Auto Detector
Set Trace Mode Max | Avg | Min	Trace 1:	Max Hold Auto Detector (Positive Peak)

Function	Trace Settings	
	Trace 2:	Average Auto Detector (Sample)
	Trace 3:	Min Hold Auto Detector (Negative Peak)
	Traces 4-6:	Blank Auto Detector
Set Trace Mode Max | ClrWrite | Min	Trace 1:	Max Hold Auto Detector (Positive Peak)
	Trace 2:	Clear Write Auto Detector (Auto Peak)
	Trace 3:	Min Hold Auto Detector (Negative Peak)
	Traces 4-6:	Blank Auto Detector

Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)
Displays the "Traces" settings and focuses the "Mode" list for the selected trace.

For details see chapter 4.3.3, "How to Configure a Standard Trace", on page 337.

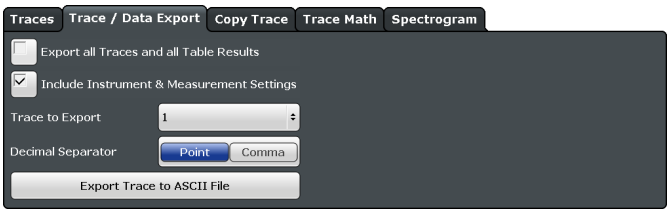
Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 612

4.3.2.2 Trace / Data Export Configuration

Access: "Overview" > "Analysis" > "Traces" > "Trace/Data Export"

The R&S FSWP provides various evaluation methods for the results of the performed measurements. However, you may want to evaluate the data with other, external applications. In this case, you can export the measurement data to an ASCII file.

The standard data management functions (e.g. saving or loading instrument settings) that are available for all R&S FSWP applications are not described here.



Export all Traces and all Table Results....331
Include Instrument Measurement Settings....331
Trace to Export....331
Decimal Separator....331
Export Trace to ASCII File....331

Export all Traces and all Table Results
Selects all displayed traces and result tables (e.g. Result Summary, marker table etc.) in the current application for export to an ASCII file.

Alternatively, you can select one specific trace only for export (see Trace to Export).

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Remote command:
`FORMat:DEXPort:TRACes` on page 616

Include Instrument Measurement Settings
Includes additional instrument and measurement settings in the header of the export file for result data.

See chapter 4.3.6, "Reference: ASCII File Export Format", on page 343 for details.

Remote command:
`FORMat:DEXPort:HEADer` on page 615

Trace to Export
Defines an individual trace that will be exported to a file.

This setting is not available if Export all Traces and all Table Results is selected.

Decimal Separator
Defines the decimal separator for floating-point numerals for the data export files. Evaluation programs require different separators in different languages.

Remote command:
`FORMat:DEXPort:DSEParator` on page 615

Export Trace to ASCII File
Opens a file selection dialog box and saves the selected trace in ASCII format (`.dat`) to the specified file and directory.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

If the spectrogram display is selected when you perform this function, the entire histogram buffer with all frames is exported to a file. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded. For large history buffers the export operation may take some time.

For details on the file format see chapter 4.3.6, "Reference: ASCII File Export Format", on page 343.

Note: Secure user mode.

In secure user mode, settings that are to be stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error may occur although the hard disk indicates that storage space is still available.

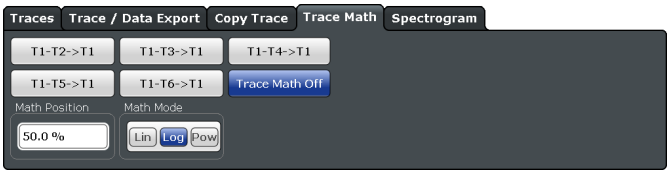
To store data permanently, select an external storage location such as a USB memory device.

For details see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSWP User Manual..

Remote command:
`MMEMory:STORe<n>:TRACe` on page 605
`MMEMory:STORe<n>:SPECtrogram` on page 622

4.3.2.3 Trace Math

Trace math settings can be configured via the TRACE key, in the "Trace Math" tab of the "Traces" dialog box.



Trace Math Function 332
Trace Math Off 332
Trace Math Position 333
Trace Math Mode 333

Trace Math Function
Defines which trace is subtracted from trace 1. The result is displayed in trace 1 and refers to the zero point defined with the Trace Math Position setting. The following subtractions can be performed:

"T1-T2 -> T1"	Subtracts trace 2 from trace 1.
"T1-T3 -> T1"	Subtracts trace 3 from trace 1
"T1-T4 -> T1"	Subtracts trace 4 from trace 1
"T1-T5 -> T1"	Subtracts trace 5 from trace 1
"T1-T6 -> T1"	Subtracts trace 6 from trace 1

To switch off the trace math, use the Trace Math Off button.

Remote command:
`CALCulate<n>:MATH[:EXPression][:DEFine]` on page 612
`CALCulate<n>:MATH:STATe` on page 614

Trace Math Off
Deactivates any previously selected trace math functions.

Remote command:
`CALC:MATH:STAT OFF`, see `CALCulate<n>:MATH:STATe` on page 614

Trace Math Position
Defines the zero point on the y-axis of the resulting trace in % of the diagram height. The range of values extends from -100 % to +200 %.

Remote command:
`CALCulate<n>:MATH:POSition` on page 613

Trace Math Mode
Defines the mode for the trace math calculations.

"Lin" Activates linear subtraction, which means that the power level values are converted into linear units prior to subtraction. After the subtraction, the data is converted back into its original unit.
This setting takes effect if the grid is set to a linear scale. In this case, subtraction is done in two ways (depending on the set unit):

- The unit is set to either W or dBm: the data is converted into W prior to subtraction, i.e. averaging is done in W.
- The unit is set to either V, A, dBmV, dBµV, dBµA or dBpW: the data is converted into V prior to subtraction, i.e. subtraction is done in V.

"Log" Activates logarithmic subtraction.
This subtraction method only takes effect if the grid is set to a logarithmic scale, i.e. the unit of the data is dBm. In this case the values are subtracted in dBm. Otherwise (i.e. with linear scaling) the behavior is the same as with linear subtraction.

"Power" Activates linear power subtraction.
The power level values are converted into unit Watt prior to subtraction. After the subtraction, the data is converted back into its original unit.
Unlike the linear mode, the subtraction is always done in W.

Remote command:
`CALCulate<n>:MATH:MODE` on page 613

4.3.2.4 Spectrogram Settings

The individual settings available for spectrogram display are described here. For settings on color mapping, see "Color Map Settings" on page 336.

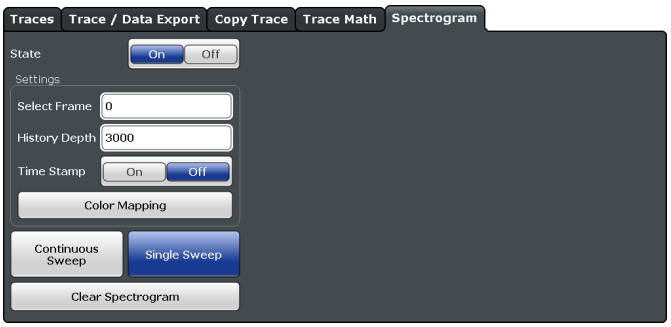
Settings concerning the frames and how they are handled during a measurement are provided as additional sweep settings for spectrogram display, see "Spectrogram Frames" on page 268.

Search functions for spectrogram markers are described in chapter 4.4.3.2, "Marker Search Settings for Spectrograms", on page 366.

- General Spectrogram Settings.....334
- Color Map Settings.....336

General Spectrogram Settings

This section describes general settings for spectrogram display. They are available when you press the TRACE key and then select the "Spectrogram Config" softkey.



State....334
Selecting a frame to display....334
History Depth....334
Timestamp....335
Color Mapping....335
Continuous Sweep/RUN CONT....335
Single Sweep/ RUN SINGLE....335
Clear Spectrogram....336

State
Activates and deactivates the spectrogram result display

Remote command:
`CALCulate<n>:SPECtrogram[:STATe]` on page 620

Selecting a frame to display
Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Spectrum window.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

The most recent frame is number 0, all previous frames have a negative number.

For more details see "Time Frames" on page 321.

Remote command:
`CALCulate<n>:SPECtrogram:FRAMe:SELect` on page 618

History Depth
Sets the number of frames that the R&S FSWP stores in its memory.

The maximum possible size of the spectrogram history depends on the available memory.

If the memory is full, the R&S FSWP deletes the oldest frames stored in the memory and replaces them with the new data.

Remote command:
CALCulate<n>:SPECtrogram:HDEPth on page 618

Timestamp
Activates and deactivates the timestamp. The timestamp shows the system time while the measurement is running. In single sweep mode or if the measurement is stopped, the timestamp shows the time and date of the end of the measurement.

When active, the timestamp replaces the display of the frame number.

Remote command:
CALCulate<n>:SPECtrogram:TSTamp[:STATe] on page 619
CALCulate<n>:SPECtrogram:TSTamp:DATA? on page 619

Color Mapping
Opens the "Color Map" dialog.

For details see "Color Maps" on page 323.

Continuous Sweep/RUN CONT
After triggering, starts the sweep and repeats it continuously until stopped. This is the default setting.

While the measurement is running, the "Continuous Sweep" softkey and the RUN CONT key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again. The results are not deleted until a new measurement is started.

Note: Sequencer. If the Sequencer is active, the "Continuous Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly.
Furthermore, the RUN CONT key controls the Sequencer, not individual sweeps. RUN CONT starts the Sequencer in continuous mode.

For details on the Sequencer, see the R&S FSWP User Manual.

Remote command:
INITiate<n>:CONTinuous on page 404

Single Sweep/ RUN SINGLE
After triggering, starts the number of sweeps set in "Sweep Count". The measurement stops after the defined number of sweeps has been performed.

While the measurement is running, the "Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in single sweep mode is swept only once by the Sequencer.

Furthermore, the RUN SINGLE key controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.

If the Sequencer is off, only the evaluation for the currently displayed measurement channel is updated.

For details on the Sequencer, see the R&S FSWP User Manual.

Remote command:
`INITiate<n>[:IMMediate]` on page 403
`CALCulate<n>:SPECtrogram:CONT` on page 617

Clear Spectrogram

Resets the spectrogram result display and clears the history buffer.

This function is only available if a spectrogram is selected.

Remote command:
`CALCulate<n>:SPECtrogram:CLEar[:IMMediate]` on page 617

Color Map Settings

Access: "Overview" > "Analysis" > "Traces" > "Spectrogram" > "Color Mapping"

For more information on color maps see "Color Maps" on page 323.

For details on changing color mapping settings see chapter 4.3.5.1, "How to Configure the Color Mapping", on page 341.

In addition to the available color settings, the dialog box displays the current color map and provides a preview of the display with the current settings.

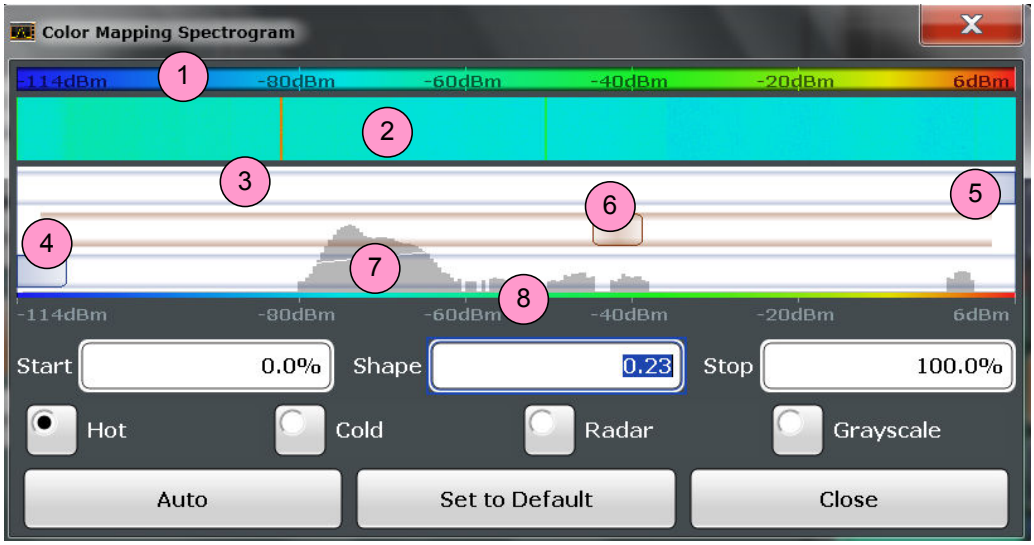


Fig. 4-13: Color Mapping dialog box

1 = Color map: shows the current color distribution
2 = Preview pane: shows a preview of the spectrogram with any changes that you make to the color scheme
3 = Color curve pane: graphical representation of all settings available to customize the color scheme
4/5 = Color range start and stop sliders: define the range of the color map or amplitudes for the spectrogram

6 = Color curve slider: adjusts the focus of the color curve
7 = Histogram: shows the distribution of measured values
8 = Scale of the horizontal axis (value range)

Start / Stop
Defines the lower and upper boundaries of the value range of the spectrogram.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer` on page 620
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer` on page 621

Shape
Defines the shape and focus of the color curve for the spectrogram result display.

"-1 to <0" More colors are distributed among the lower values
"0" Colors are distributed linearly among the values
">0 to 1" More colors are distributed among the higher values

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe` on page 621

Hot/Cold/Radar/Grayscale
Sets the color scheme for the spectrogram.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe]` on page 621

Auto
Defines the color range automatically according to the existing measured values for optimized display.

Set to Default
Sets the color mapping to the default settings.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault` on page 620

4.3.2.5 How to Copy Traces

You can copy the trace settings from one trace to another in the "Copy Trace" tab of the "Traces" dialog box.

► Select the "Source" trace and then the button for the "Copy to" trace.

Remote command:

`TRACe<n>:COPY` on page 612

4.3.3 How to Configure a Standard Trace

Step-by-step instructions on configuring the trace settings are provided here.

For details on individual functions and settings see chapter 4.3.2.1, "Trace Settings", on page 326.

The remote commands required to perform these tasks are described in chapter 5.8.2, "Remote Commands to Configure Traces", on page 605.

Trace settings are configured in the "Traces" dialog box.

To display the "Traces" dialog box, do one of the following:

- Press the TRACE key and then select the "Trace Config" softkey.
- Select "Analysis" from the "Overview", then select the "Traces" tab.

1. For each trace, select the "Trace Mode" and "Trace Detector". Traces with the trace mode "Blank" are not displayed.
2. To configure several traces to predefined display modes in one step, press the button for the required function:
   - "Preset All Traces"
   - "Set Trace Mode Avg | Max | Min"
   - "Set Trace Mode Max | ClrWrite | Min"

   For details see chapter 4.3.2.1, "Trace Settings", on page 326.
3. For "Average" trace mode, define the number of measurements to be averaged in the "Count" field.
4. If linear scaling is used, select the "Average Mode: Linear".
5. To improve the trace stability, increase the number of "Measurement Points" or the "Measurement Time" (in the "Sweep" settings).

   All configured traces (not set to "Blank") are displayed after the next measurement.

How to Copy Traces

1. A trace copy function is provided in a separate tab of the "Traces" dialog box. To display this tab do one of the following:
   - Select the TRACE key and then the "Trace Copy" softkey.
   - Select "Analysis" from the "Overview", then select the "Trace Copy" tab.
2. Select the "Source" trace to be copied.
3. Select the "Copy to trace..." button for the trace to which the settings are to be applied.

   The settings from the source trace are applied to the destination trace. The newly configured trace (if not set to "Blank") is displayed after the next measurement.

4.3.4 How to Export Trace Data and Numerical Results

The measured trace data and numerical measurement results in tables can be exported to an ASCII file. For each measurement point the measured trace position and

value are output. The file is stored with a `.DAT` extension. For details on the storage format see chapter 4.3.6, "Reference: ASCII File Export Format", on page 343.

To export trace data and table results

Trace data can be exported either from the "Trace" menu, or from the "Save/Recall" menu.

1. Press the TRACE key, then select the "Trace Config" softkey and switch to the "Trace/Data Export" tab.
   Or:
   Select the "Save" icon in the toolbar, then select the "Export" softkey.
2. Select the "Export Config" softkey to configure the export settings.
   a) Select "Export all Traces and all Table Results" to export all available measurement result data for the current application, or select a specific "Trace to Export".
   b) Optionally, select the "Include Instrument Measurement Settings" option to insert additional information in the export file header.
   c) If necessary, change the decimal separator to be used for the ASCII export file.
3. Select the "Export Trace to ASCII file" button.
4. In the file selection dialog box, select the storage location and file name for the export file.
5. Select "Save" to close the dialog box and export the data to the file.

4.3.5 How to Display and Configure a Spectrogram

Step-by-step instructions on how to display and configure a spectrogram are provided here. For details on individual functions and settings see chapter 4.3.2.4, "Spectrogram Settings", on page 333.

The remote commands required to perform these tasks are described in chapter 5.8.2.5, "Configuring Spectrograms", on page 616.

The following tasks are described here:

- "To display a spectrogram" on page 340
- "To remove the spectrogram display" on page 340
- "To set a marker in the spectrogram" on page 340
- "To configure a spectrogram" on page 340
- "To select a color scheme" on page 341
- "To set the value range graphically using the color range sliders" on page 341
- "To set the value range numerically" on page 342
- "To set the color curve shape graphically using the slider" on page 343
- "To set the color curve shape numerically" on page 343

To display a spectrogram

1. In the "Overview", select "Display", then drag the evaluation type "Spectrogram" to the diagram area.
   Alternatively:
   a) Select the TRACE key and then the "Spectrogram Config" softkey.
   b) Toggle "Spectrogram" to "ON".
2. To clear an existing spectrogram display, select "Clear Spectrogram".
3. Start a new measurement using RUN SINGLE or RUN CONT.
   The spectrogram is updated continuously with each new sweep.
4. To display the spectrum diagram for a specific time frame:
   a) Stop the continuous measurement or wait until the single sweep is completed.
   b) Select the frame number in the diagram footer.
   c) Enter the required frame number in the edit dialog box.
   Note that the most recent sweep is frame number 0, all previous frames have negative numbers.

To remove the spectrogram display

1. Select the TRACE key and then the "Spectrogram Config" softkey.
2. Toggle "Spectrogram" to "OFF".
   The standard spectrum display is restored.

To set a marker in the spectrogram

1. While a spectrogram is displayed, select the MARKER key.
2. Select a "Marker" softkey.
3. Enter the frequency or time (x-value) of the marker or delta marker.
4. Enter the frame number for which the marker is to be set, for example *0* for the current frame, or *-2* for the second to last frame. Note that the frame number is always 0 or a negative value!
   The marker is only visible in the spectrum diagram if it is defined for the currently selected frame. In the spectrogram result display all markers are visible that are positioned on a visible frame.

To configure a spectrogram

1. Configure the spectrogram frames:
   a) Select the SWEEP key.
   b) Select the "Sweep Config" softkey.
   c) In the "Sweep/Average Count" field, define how many sweeps are to be analyzed to create a single frame.
   d) In the "Frame Count" field, define how many frames are to be plotted during a single sweep measurement.

e) To include frames from previous sweeps in the analysis of the new frame (for "Max Hold", "Min Hold" and "Average" trace modes only), select "Continue Frame" = "ON".

2. Define how many frames are to be stored in total:
   a) Select the TRACE key and then the "Spectrogram Config" softkey.
   b) Select the "History Depth" softkey.
   c) Enter the maximum number of frames to store.
3. Optionally, replace the frame number by a time stamp by toggling the "Timestamp" softkey to "On".
4. If necessary, adapt the color mapping for the spectrogram to a different value range or color scheme as described in chapter 4.3.5.1, "How to Configure the Color Mapping", on page 341.

4.3.5.1 How to Configure the Color Mapping

The color display is highly configurable to adapt the spectrograms to your needs.

The settings for color mapping are defined in the "Color Mapping" dialog box. To display this dialog box, do one of the following:

- Select the color map in the spectrogram display.
- Select the "Color Mapping" softkey in the "Spectrogram" menu.

To select a color scheme

You can select which colors are assigned to the measured values.

► In the "Color Mapping" dialog box, select the option for the color scheme to be used.

Editing the value range of the color map

The distribution of the measured values is displayed as a histogram in the "Color Mapping" dialog box. To cover the entire measurement value range, make sure the first and last bar of the histogram are included.

To ignore noise in a spectrogram, for example, exclude the lower power levels from the histogram.

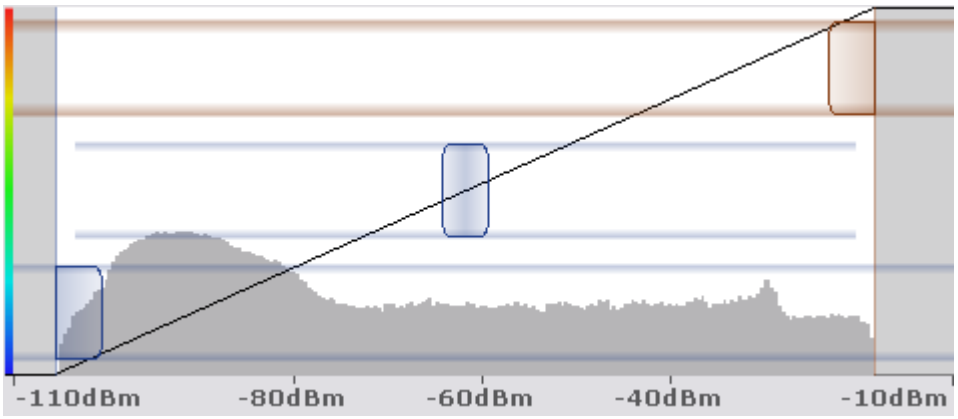
The value range of the color map must cover at least 10% of the value range on the horizontal axis of the diagram, that means, the difference between the start and stop values must be at least 10%.

The value range can be set numerically or graphically.

To set the value range graphically using the color range sliders

1. Select and drag the bottom color curve slider (indicated by a gray box at the left of the color curve pane) to the lowest value you want to include in the color mapping.

2. Select and drag the top color curve slider (indicated by a gray box at the right of the color curve pane) to the highest value you want to include in the color mapping.



To set the value range numerically

1. In the "Start" field, enter the percentage from the left border of the histogram that marks the beginning of the value range.
2. In the "Stop" field, enter the percentage from the right border of the histogram that marks the end of the value range.

Example:

The color map starts at -100 dBm and ends at 0 dBm (i.e. a range of 100 dB). In order to suppress the noise, you only want the color map to start at -90 dBm. Thus, you enter *10%* in the "Start" field. The R&S FSWP shifts the start point 10% to the right, to -90 dBm.

Adjusting the reference level and level range

Note that changing the reference level and level range of the measurement also affects the color mapping in the spectrogram.

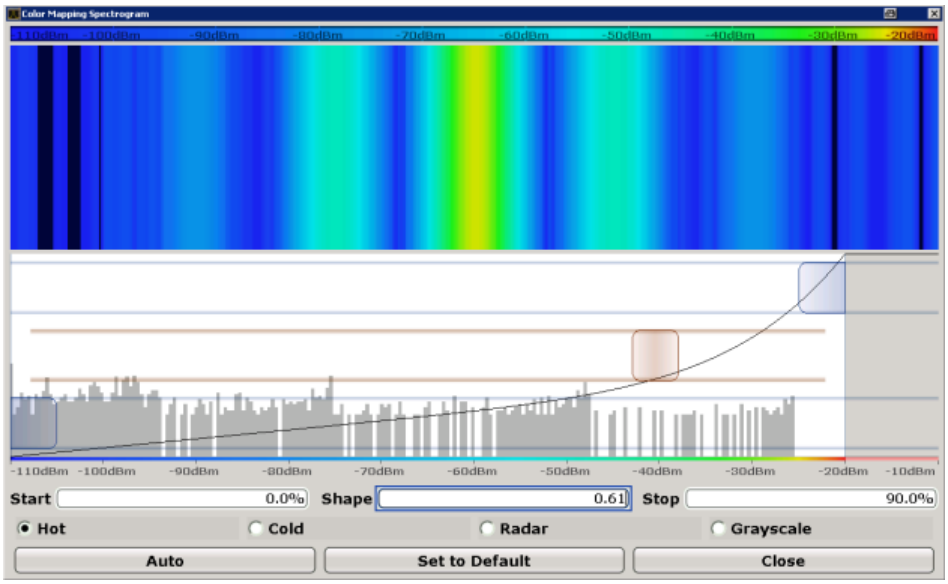
Editing the shape of the color curve

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear, i.e. the colors on the color map are distributed evenly. If you shift the curve to the left or right, the distribution becomes non-linear. The slope of the color curve increases or decreases. One end of the color palette then covers a large amount of results, while the other end distributes several colors over a relatively small result range.

The color curve shape can be set numerically or graphically.

To set the color curve shape graphically using the slider

► Select and drag the color curve shape slider (indicated by a gray box in the middle of the color curve) to the left or right. The area beneath the slider is focussed, i.e. more colors are distributed there.



To set the color curve shape numerically

► In the "Shape" field, enter a value to change the shape of the curve:

- A negative value (-1 to <0) focusses the lower values
- 0 defines a linear distribution
- A positive value (>0 to 1) focusses the higher values

4.3.6 Reference: ASCII File Export Format

Trace data can be exported to a file in ASCII format for further evaluation in other applications. This reference describes in detail the format of the export files for result data.

(For details see chapter 4.3.4, "How to Export Trace Data and Numerical Results", on page 338).

For a description of the file formats for spectrum emission mask (SEM) measurement settings and results, see chapter 2.6.8, "Reference: SEM File Descriptions", on page 134.

The file format for Spurious Emissions measurement results is described in chapter 2.7.6, "Reference: ASCII Export File Format (Spurious)", on page 152.

The file consists of the header information (general configuration of the measurement) and the measurement results. Optionally, the header can be excluded from the file.

The file of the Phase Noise application contains several sections, each section containing related data as shown in the tables below. Each section can contain header information and / or result information (header information is represented by a blue font in the tables below).

The data of the file header consist of three columns, each separated by a semicolon: parameter name; numeric value; basic unit. The data section starts with the keyword "Trace <n>" (<n> = number of stored trace), followed by the measured data in one or several columns (depending on the measurement) which are also separated by a semicolon.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Generally, the format of this ASCII file can be processed by spreadsheet calculation programs, e.g. MS-Excel. Different language versions of evaluation programs may require a different handling of the decimal point. Thus you can define the decimal separator to be used (decimal point or comma.

If the spectrogram display is selected when you select the "ASCII Trace Export" softkey, the entire histogram buffer with all frames is exported to a file. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Table 4-3: ASCII file format for trace export in the Spectrum application

File contents	Description
Header data	
Type;R&S FSWP;	Instrument model
Version;1.00;	Firmware version
Date;01.Oct 2006;	Date of data set storage
Mode;ANALYZER;	Operating mode
Preamplifier;OFF	Preamplifier status
Transducer; OFF	Transducer status
Center Freq;55000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz for span > 0, s for span = 0, dBm/dB for statistics measurements
Span;90000;Hz	Frequency range (0 Hz in zero span and statistics measurements)
Ref Level;-30;dBm	Reference level
Level Offset;0;dB	Level offset
Rf Att;20;dB	Input attenuation
El Att;2.0;dB	Electrical attenuation
RBW;100000;Hz	Resolution bandwidth

File contents	Description
VBW;30000;Hz	Video bandwidth
SWT;0.005;s	Sweep time
Sweep Count;20;	Number of sweeps set
Ref Position;75;%	Position of reference level referred to diagram limits (0 % = lower edge)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN
x-Axis;LIN;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
y-Axis;LOG;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
Data section for individual window	
Window;1;Frequency Sweep	Window number and name
Trace 1;;	Selected trace
Trace Mode;AVERAGE;	Display mode of trace: CLR/WRITE,AVERAGE,MAXHOLD,MINHOLD
Detector;AUTOPEAK;	Detector set: AUTOPEAK,MAXPEAK,MINPEAK,AVERAGE,RMS,SAMPLE,QUASIPEAK
Values; 1001;	Number of measurement points
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values: <x value>, <y1>, <y2>; <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a measurement point.
Data section for individual trace	
Trace 2;;	Next trace in same window
...	
Data section for individual window	
Window;2 ..;	Name of next window
Data section for individual trace	
Trace 1;;	First trace
...	

Table 4-4: ASCII file format for spectrogram trace export

File contents	Description
Header	
Type;R&S FSWP;	Instrument model
Version;5.00;	Firmware version
Date;01.Oct 2006;	Date of data set storage
Mode;ANALYZER;**SPECTROGRAM**	Operating mode
Center Freq;55000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Span;90000;Hz	Frequency range (0 Hz in zero span and statistics measurements)
x-Axis;LIN;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz for span > 0, s for span = 0, dBm/dB for statistics measurements
Ref Level;-30;dBm	Reference level
Level Offset;0;dB	Level offset
Ref Position;75; %	Position of reference level referred to diagram limits (0 % = lower edge)
y-Axis;LOG;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN
Rf Att;20;dB	Input attenuation
RBW;100000;Hz	Resolution bandwidth
VBW;30000;Hz	Video bandwidth
SWT;0.005;s	Sweep time
Trace Mode;AVERAGE;	Display mode of trace: CLR/WRITE,AVERAGE,MAXHOLD,MINHOLD
Detector;AUTOPEAK;	Detector set: AUTOPEAK,MAXPEAK,MINPEAK,AVERAGE,RMS,SAMPLE,QUASIPEAK
Sweep Count;20;	Number of sweeps set
Data section	
Trace 1:;;	Selected trace
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
Values; 1001;	Number of measurement points

File contents	Description
Frames;2;	**Number of exported frames**
Frame;0;	**Most recent frame number**
Timestamp;17.Mar 11;11:27:05.990	**Timestamp of this frame**
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values, identical to spectrum data: <x value>, <y1>, <y2>; <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a measurement point.
Frame;-1;	**Next frame**
Timestamp;17.Mar 11;11:27:05.342	**Timestamp of this frame**
...	

4.3.7 Formats for Returned Values: ASCII Format and Binary Format

When trace data is retrieved using the `TRAC:DATA` or `TRAC:IQ:DATA` command, the data is returned in the format defined using the `FORMat[:DATA]`. The possible formats are described here.

- ASCII Format (FORMat ASCII):
  The data is stored as a list of comma separated values (CSV) of the measured values in floating point format.
- Binary Format (FORMat REAL,32):
  The data is stored as binary data (Definite Length Block Data according to IEEE 488.2), each measurement value being formatted in 32 Bit IEEE 754 Floating-Point-Format.
  The schema of the result string is as follows:
  `#41024<value1><value2>…<value n>` with

#4	number of digits (= 4 in the example) of the following number of data bytes
1024	number of following data bytes (= 1024 in the example)
<Value>	4-byte floating point value

Reading out data in binary format is quicker than in ASCII format. Thus, binary format is recommended for large amounts of data.

4.4 Marker Usage

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display both in the time and frequency domain. In addition to basic markers, sophisticated marker functions are provided for special results such as noise or demodulation.

Markers in Spectrogram Displays

In the spectrogram result display, you can activate up to 16 markers or delta markers at the same time. Each marker can be assigned to a different frame. Therefore, in addition to the frequency you also define the frame number when activating a new marker. If no frame number is specified, the marker is positioned on the currently selected frame. All markers are visible that are positioned on a visible frame.

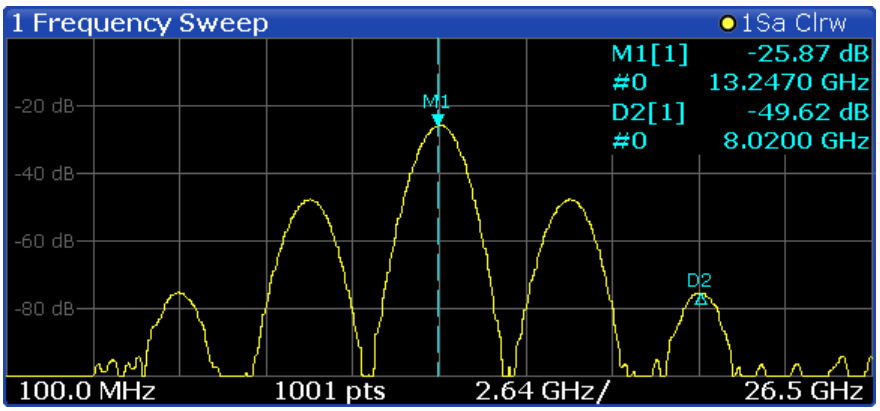
- Basics on Markers and Marker Functions....348
- Marker Settings....358
- Marker Search Settings and Positioning Functions....363
- Marker Function Configuration....369
- How to Work With Markers....378
- Measurement Example: Measuring Harmonics Using Marker Functions....380

4.4.1 Basics on Markers and Marker Functions

Some background knowledge on marker settings and functions is provided here for a better understanding of the required configuration settings.

Markers are used to mark points on traces, to read out measurement results and to select a display section quickly. R&S FSWP provides 16 markers per display window. In the Spectrum application, the same markers are displayed in all windows.

- The easiest way to work with markers is using the touch screen. Simply drag the marker and drop it at the required position. When a marker label is selected, a vertical line is displayed which indicates the marker's current x-value.



- Alternatively, change the position of the selected marker using the rotary knob. By default, the marker is moved from one pixel to the next. If you need to position the marker more precisely, change the step size to move from one sweep point to the next (General Marker Setting).
- You can also set an active marker to a new position by defining its x-position numerically. When you select the softkey for a marker, an edit dialog box is displayed.
- The most commonly required marker settings and functions are also available as softkeys or via the context menu. Tap the marker on the touch screen and hold

your finger for about 2 seconds until the context menu is opened, then select the required entry.

- Softkeys for active markers (displayed on the screen) are highlighted blue. The softkey for the currently selected marker (for which functions are performed) is highlighted orange.
- To set individual markers very quickly, use the softkeys in the "Marker" menu.
- To set up several markers at once, use the "Marker" dialog box.
- To position the selected marker to a special value, use the softkeys in the "Marker To" menu.
- To determine more sophisticated marker results, use the special functions in the "Marker Function" dialog box.

In addition to basic markers, sophisticated marker functions are provided for special results such as noise or demodulation.

- Marker Types 349
- Activating Markers 349
- Marker Results 350
- Searching for Signal Peaks 351
- Performing a Highly Accurate Frequency Measurement (Signal Count) 353
- Defining a Fixed Reference Marker 353
- Measuring Noise Density 354
- Measuring Phase Noise 355
- Measuring Characteristic Bandwidths (n dB Down Marker) 356
- Measuring the Power in a Channel (Band) 357

4.4.1.1 Marker Types

All markers can be used either as normal markers or delta markers. A normal marker indicates the absolute signal value at the defined position in the diagram. A delta marker indicates the value of the marker relative to the specified reference marker (by default marker 1).

The Spectrum application also features special functions that can be assigned to individual markers. The availability of special marker functions depends on whether the measurement is performed in the frequency or time domain.

Temporary markers are used in addition to the markers and delta markers to analyze the measurement results for special marker functions. They disappear when the associated function is deactivated.

4.4.1.2 Activating Markers

Only active markers are displayed in the diagram and in the marker table.

Active markers are indicated by a highlighted softkey.

By default, marker 1 is active and positioned on the maximum value (peak) of trace 1 as a normal marker. If several traces are displayed, the marker is set to the maximum value of the trace which has the lowest number and is not frozen (View mode). The

next marker to be activated is set to the frequency of the next lower level (next peak) as a delta marker; its value is indicated as an offset to marker 1.

A marker can only be activated when at least one trace in the corresponding window is visible. If a trace is switched off, the corresponding markers and marker functions are also deactivated. If the trace is switched on again, the markers along with coupled functions are restored to their original positions, provided the markers have not been used on another trace.

4.4.1.3 Marker Results

Normal markers point to a trace point on the x-axis and display the associated numeric value for that trace point. Delta markers indicate an offset between the level at the delta marker position and the level at the position of the assigned reference marker, in dB.

Signal count markers determine the frequency of a signal at the marker position very accurately.

The results can be displayed directly within the diagram area or in a separate table. By default, the first two active markers are displayed in the diagram area. If more markers are activated, the results are displayed in a marker table.

Marker information in diagram area

By default, the results of the last two markers or delta markers that were activated are displayed in the diagram area.

The following information is displayed there:

- The marker type (M for normal, D for delta, or special function name)
- The marker number (1 to 16)
- The assigned trace number in square brackets [ ]
- The marker value on the y-axis, or the result of the marker function
- The marker position on the x-axis

For n dB down markers, additional information is displayed, see chapter 4.4.1.9, "Measuring Characteristic Bandwidths (n dB Down Marker)", on page 356.

Marker information in marker table

In addition to the marker information displayed within the diagram area, a separate marker table may be displayed beneath the diagram. This table provides the following information for all active markers:

Table 4-5: Contents of the marker table in the Spectrum application

Type	Marker type: N (normal), D (delta), T (temporary, internal) and number
Ref	Reference marker for delta markers
Trc	Trace to which the marker is assigned
Frame	Spectrogram frame the marker is positioned in. Displayed only when the Spectrogram is displayed.
X-value	X-value of the marker
Y-value	Y-value of the marker
Function	Activated marker or measurement function
Function Result	Result of the active marker or measurement function

4.4.1.4 Searching for Signal Peaks

A common measurement task is to determine peak values, i.e. maximum or minimum signal levels. The R&S FSWP provides various peak search functions and applications:

- Setting a marker to a peak value once (Peak Search)
- Searching for a peak value within a restricted search area (Search Limits)
- Creating a marker table with all or a defined number of peak values for one measurement (Marker Peak List)
- Updating the marker position to the current peak value automatically after each measurement (Auto Peak Search)
- Creating a fixed reference marker at the current peak value of a trace (Fixed Reference)

Peak search limits

The peak search can be restricted to a search area. The search area is defined by limit lines which are also indicated in the diagram. In addition, a minimum value (threshold) can be defined as a further search condition.

When is a peak a peak? - Peak excursion

During a peak search, for example when a marker peak table is displayed, noise values may be detected as a peak if the signal is very flat or does not contain many peaks. Therefore, you can define a relative threshold ("Peak excursion"). The signal level must increase by the threshold value before falling again before a peak is detected. To avoid identifying noise peaks as maxima or minima, enter a peak excursion value that is higher than the difference between the highest and the lowest value measured for the displayed inherent noise.

Effect of peak excursion settings (example)

The following figure shows a trace to be analyzed.

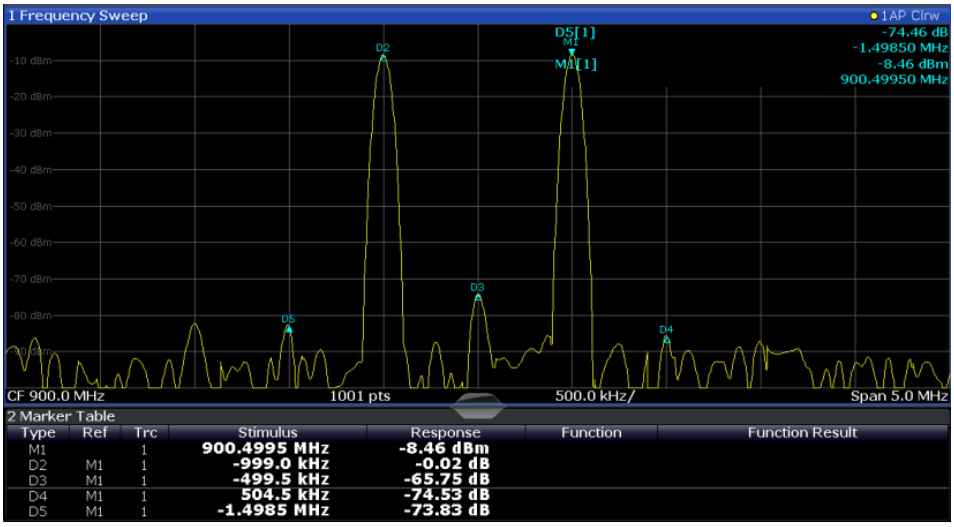


Fig. 4-14: Trace example

The following table lists the peaks as indicated by the marker numbers in the diagram above, as well as the minimum decrease in amplitude to either side of the peak:

Marker #	Min. amplitude decrease to either side of the signal
1	30 dB
2	29.85 dB
3	20 dB
4	10 dB
5	18 dB

In order to eliminate the smaller peaks M3,M4 and M5 in the example above, a peak excursion of at least 20 dB is required. In this case, the amplitude must rise at least 20 dB before falling again before a peak is detected.

Marker peak list

The marker peak list determines the frequencies and levels of peaks in the spectrum. It is updated automatically after each measurement. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.

Automatic peak search

A peak search can be repeated automatically after each measurement in order to keep the maximum value as the reference point for a phase noise measurement. This is useful to track a drifting source. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore the phase noise measurement leads to reliable results in a certain offset although the source is drifting.

Using a peak as a fixed reference marker

Some results are analyzed in relation to a peak value, for example a carrier frequency level. In this case, the maximum level can be determined by an initial peak search and then be used as a reference point for further measurement results.

4.4.1.5 Performing a Highly Accurate Frequency Measurement (Signal Count)

A normal marker determines the position of the point on the trace and indicates the signal frequency at this position. The trace, however, contains only a limited number of points. Depending on the selected span, each trace point may contain many measurement values. Thus, the frequency resolution of each trace point is limited (see also chapter 3.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 260). Frequency resolution is further restricted by the RBW and sweep time settings.

In order to determine the frequency of a signal point accurately without changing the sweep settings, the R&S FSWP is equipped with a signal counter. The signal counter sets the RF to the current marker position, then counts the zero crossings of the IF (thus the term signal *counter*) and derives the precise frequency value.

Signal counting can be performed explicitely at the current marker position ("Signal Count" marker function), or implicitely by the R&S FSWP for certain functions.

Signal counting is only possible while the instrument is not sweeping. Thus, to perform a signal count for a marker, the sweep is stopped at the marker position. The frequency is determined with the desired resolution and then the sweep is allowed to continue.

Remote commands:

`CALCulate<n>:MARKer<m>:COUNt` on page 647

`CALCulate<n>:MARKer<m>:COUNt:RESolution` on page 648

4.4.1.6 Defining a Fixed Reference Marker

Access: "Overview" > "Analysis" > "Marker" > "Marker Functions" > "Reference Fixed"

Instead of using a reference marker that may vary its position depending on the measurement results, a fixed reference marker can be defined for trace analysis. Once positioned, the reference marker does not move during subsequent sweeps unless you explicitely move it manually.

Remote commands:

`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed[:STATe]` on page 629

`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X` on page 628

`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y` on page 628

4.4.1.7 Measuring Noise Density

Using the noise measurement marker function, the noise power density is measured at the position of the marker. In the time domain mode, all points of the trace are used to determine the noise power density. When measurements are performed in the frequency domain, two points to the right and left of the marker are used for the measurement to obtain a stable result.

Result display

Noise density is the noise referred to a bandwidth of 1 Hz. With logarithmic amplitude units (dBm, dBmV, dBmµV, dBµA), the noise power density is output in dBm/Hz, i.e. as level in 1 Hz bandwidth with reference to 1 mW. With linear amplitude units (V, A, W), the noise voltage density is analyzed in µV/√Hz, the noise current density in µA/√Hz or the noise power density in µW/√Hz.

The result is indicated as the **function result in the Marker Table**.

Prerequisite settings

The following settings have to be made to obtain correct values:

- Detector: Sample or RMS
- Video bandwidth:
  ≤ 0.1 resolution bandwidth with sample detector
  ≥ 3 x resolution bandwidth with RMS detector
- Trace averaging:
  In the default setting, the R&S FSWP uses the sample detector for the noise function. With the sample detector, the trace can additionally be set to "Average" mode to stabilize the measured values. When the RMS detector is used, trace averaging should not be used since in this case it produces too low noise levels which cannot be corrected. Instead, the sweep time can be increased to obtain stable measurement results.

Correction factors

The R&S FSWP uses the following correction factors to analyze the noise density from the marker level:

- Since the noise power is indicated with reference to 1 Hz bandwidth, the bandwidth correction value is deducted from the marker level. It is 10 x lg (1 Hz/BWNoise), where BWNoise is the noise or power bandwidth of the set resolution filter (RBW).
- RMS detector: With the exception of bandwidth correction, no further corrections are required since this detector already indicates the power for each point of the trace.
- Sample detector: As a result of video filter averaging and trace averaging, 1.05 dB is added to the marker level. This is the difference between the average value and the RMS value of white noise. With a logarithmic level axis, 1.45 dB is added additionally. Logarithmic averaging is thus fully taken into account which yields a value that is 1.45 dB lower than that of linear averaging.

- To allow a more stable noise display the adjacent (symmetric to the measurement frequency) points of the trace are averaged.
- For span > 0, the measured values are averaged versus time (after a sweep).

The R&S FSWP noise figure can be calculated from the measured power density level. It is calculated by deducting the set RF attenuation (RF Att) from the displayed noise level and adding 174 to the result.

Remote commands:

`CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe]` on page 649

`CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult?` on page 649

4.4.1.8 Measuring Phase Noise

Phase noise is unintentional modulation of a carrier; it creates frequencies next to the carrier frequency. A phase noise measurement consists of noise density measurements at defined offsets from the carrier; the results are given in relation to the carrier level (dBc). The phase noise marker function measures the noise power at the delta markers referred to 1 Hz bandwidth. Marker 1 is used as the reference for the phase noise measurement. By default, the current frequency and level of marker 1 are used as the fixed reference marker. However, a peak search can be started to use the current signal peak as the reference point, or a reference point can be defined manually.

Since the reference point is fixed, the reference level or the center frequency can be set so that the carrier is outside the displayed frequency range after phase noise measurement is started. Or a notch filter can be switched on to suppress the carrier.

Alternatively, the reference point can be determined automatically by a peak search after each sweep. This function can be used to track a drifting source during a phase noise measurement. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore the phase noise measurement leads to reliable results in a certain offset although the source is drifting. Only if the marker 2 reaches the border of the span, the delta marker value is adjusted to be within the span. In these cases, select a larger span.

The result of the phase noise measurement is the difference in level between the reference point and the noise power density. It is indicated as the function result of the phase noise marker in the Marker Table.

The sample detector is automatically used and the video bandwidth set to 0.1 times the resolution bandwidth (RBW). The two settings are taken into account in the correction values used for the noise power measurement. To obtain stable results, two pixels on the right and the left of the delta marker position are taken for the measurement.

The procedure for determining the noise power is identical to the method used for the noise power measurement (see chapter 4.4.1.7, "Measuring Noise Density", on page 354).

Remote commands:

CALCulate<n>:MARKer<m>:FUNCtion:PNOise[:STATe] on page 651

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe] on page 650

CALCulate<n>:MARKer<m>:FUNCtion:PNOise:RESult? on page 651

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult? on page 650

4.4.1.9 Measuring Characteristic Bandwidths (n dB Down Marker)

When characterizing the shape of a signal, the bandwidth at a specified offset from its peak level is often of interest. The offset is specified as a relative decrease in amplitude of n dB. In order to measure this bandwidth, you could use several markers and delta markers and determine the bandwidth manually. However, using the n dB down marker function makes the task very simple and quick.

The n dB down marker function uses the current value of marker 1 as the reference point. It activates two temporary markers T1 and T2 located on the signal, whose level is n dB below the level of the reference point. Marker T1 is placed to the left and marker T2 to the right of the reference marker. The default setting for n is 3 dB, but it can be changed.

If a positive offset is entered, the markers T1 and T2 are placed below the active reference point. If a negative value is entered (for example for notch filter measurements), the markers T1 and T2 are placed above the active reference point.

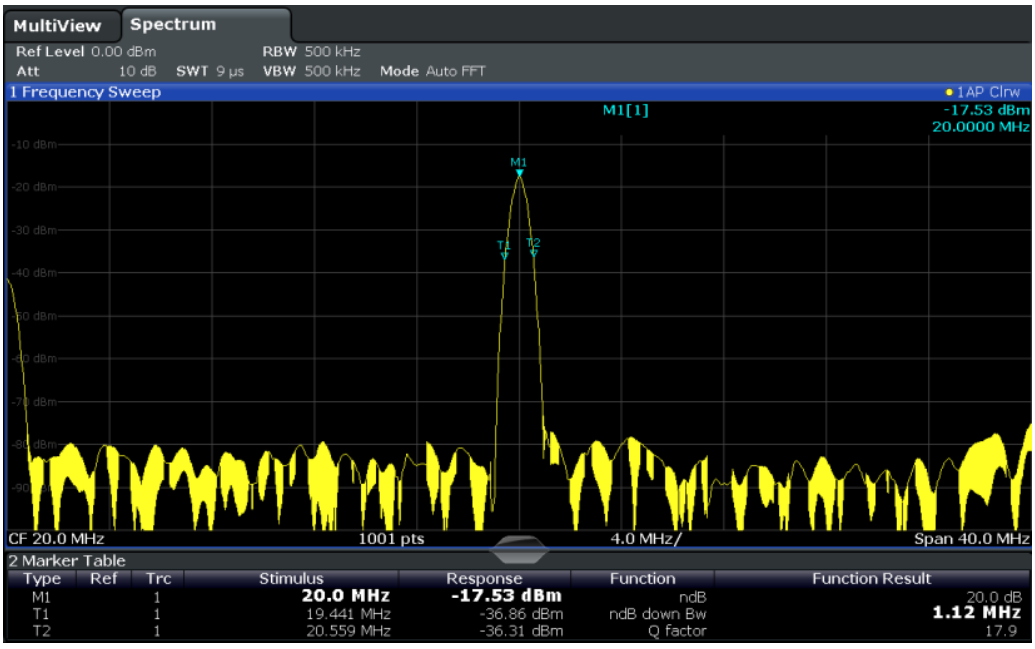


Fig. 4-15: n dB down marker function

The following marker function results are displayed:

Table 4-6: n dB down marker function results

Label	Description
M1	Current position and level of marker 1
ndB	Offset value (n dB down)
ndB down Bw / PWid	Determined bandwidth or pulse width (zero span) at the offset
Q-factor	Quality factor of the determined bandwidth (characteristic of damping or resonance)
T1, T2	Current position and level of the temporary markers

If the required position for the temporary markers cannot be determined uniquely, for example due to noise, dashes are displayed as a result.

Remote commands:

`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:STATe` on page 653

`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult?` on page 653

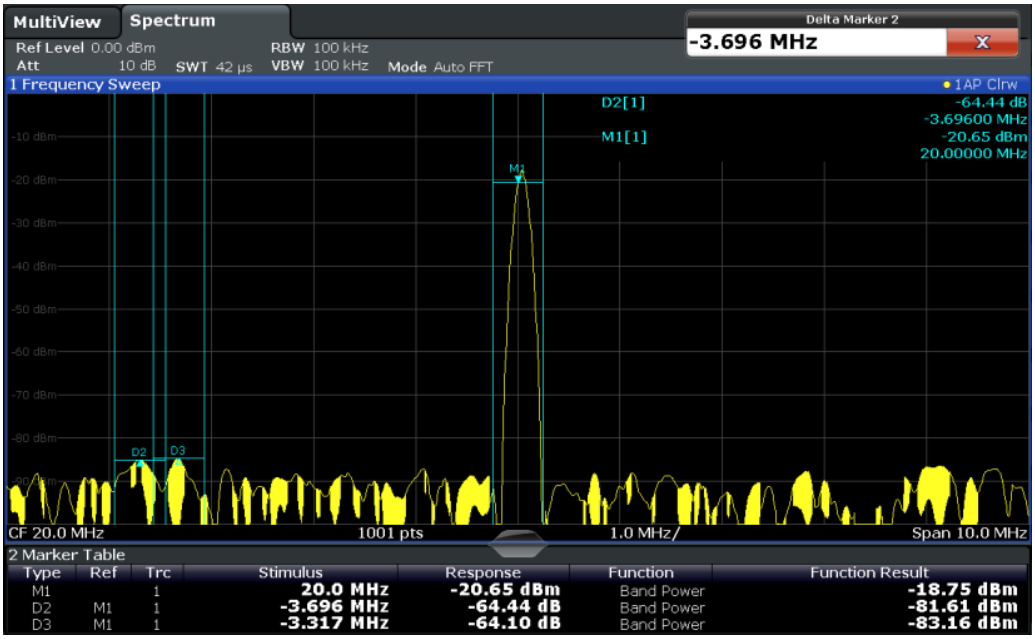
4.4.1.10 Measuring the Power in a Channel (Band)

To determine the noise power in a transmission channel, you could use a noise marker and multiply the result with the channel bandwidth. However, the results would only be accurate for flat noise.

Band power markers allow you to measure the integrated power for a defined span (band) around a marker (similar to ACP measurements). By default, 5 % of the current span is used. The span is indicated by limit lines in the diagram. The results can be displayed either as a power (dBm) or density (dBm/Hz) value and are indicated in the marker table for each band power marker.

Band power markers are only available for standard frequency measurements (not zero span) in the Spectrum application.

The entire band must lie within the display. If it is moved out of the display, the result cannot be calculated (indicated by "- - -" as the "Function Result"). However, the width of the band is maintained so that the band power can be calculated again when it returns to the display.



All markers can be defined as band power markers, each with a different span. When a band power marker is activated, if no marker is active yet, marker 1 is activated. Otherwise, the currently active marker is used as a band power marker (all other marker functions for this marker are deactivated).

If the detector mode for the marker trace is set to "Auto", the RMS detector is used.

Remote commands:

`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe]` on page 657

`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult?` on page 656

4.4.2 Marker Settings

Marker settings can be configured via the MARKER menu or in the "Marker" dialog box.

To display the "Marker" dialog box, do one of the following:

- Press the MKR key, then select the "Marker Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker" tab.

The remote commands required to define these settings are described in chapter 5.8.3.1, "Individual Marker Setup", on page 622.

- Individual Marker Setup 359
- General Marker Settings 361

4.4.2.1 Individual Marker Setup

Up to 17 markers or delta markers can be activated for each window simultaneously. Initial marker setup is performed using the "Marker" dialog box.

The markers are distributed among 3 tabs for a better overview. By default, the first marker is defined as a normal marker, whereas all others are defined as delta markers with reference to the first marker. All markers are assigned to trace 1, but only the first marker is active.

Selected Marker 359
Marker State 359
Marker Position (X-value) 359
Frame (Spectrogram only) 360
Marker Type 360
Reference Marker 360
Linking to Another Marker 360
Assigning the Marker to a Trace 361
Select Marker 361
All Markers Off 361

Selected Marker
Marker name. The marker which is currently selected for editing is highlighted orange.

Remote command:
Marker selected via suffix <m> in remote commands.

Marker State
Activates or deactivates the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 626
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 624

Marker Position (X-value)
Defines the position (x-value) of the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>:X` on page 627
`CALCulate<n>:DELTamarker<m>:X` on page 625

Frame (Spectrogram only)
Spectrogram frame the marker is assigned to.

Remote command:
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe on page 626
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe on page 624

Marker Type
Toggles the marker type.

The type for marker 1 is always "Normal", the type for delta marker 1 is always "Delta". These types cannot be changed.

Note: If normal marker 1 is the active marker, switching the "Mkr Type" activates an additional delta marker 1. For any other marker, switching the marker type does not activate an additional marker, it only switches the type of the selected marker.

"Normal" A normal marker indicates the absolute value at the defined position in the diagram.

"Delta" A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
CALCulate<n>:MARKer<m>[:STATe] on page 626
CALCulate<n>:DELTamarker<m>[:STATe] on page 624

Reference Marker
Defines a marker as the reference marker which is used to determine relative analysis results (delta marker values).

If the reference marker is deactivated, the delta marker referring to it is also deactivated.

If a fixed reference point is configured (see "Defining a Fixed Reference" on page 362), the reference point ("FXD") can also be selected instead of another marker.

Remote command:
CALCulate<n>:DELTamarker<m>:MREF on page 624

Linking to Another Marker
Links the current marker to the marker selected from the list of active markers. If the x-axis value of the inital marker is changed, the linked marker follows on the same x-position. Linking is off by default.

Using this function you can set two markers on different traces to measure the difference (e.g. between a max hold trace and a min hold trace or between a measurement and a reference trace).

Remote command:
CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m> on page 626
CALCulate<n>:DELTamarker<m>:LINK:TO:MARKer<m> on page 623
CALCulate<n>:DELTamarker<m>:LINK on page 623

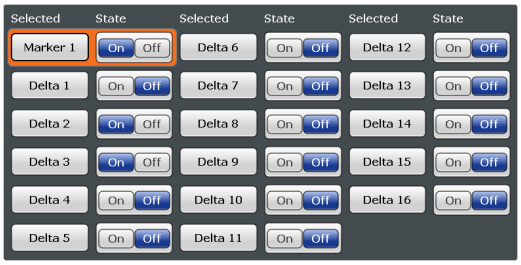
Assigning the Marker to a Trace
The "Trace" setting assigns the selected marker to an active trace. The trace determines which value the marker shows at the marker position. If the marker was previously assigned to a different trace, the marker remains on the previous frequency or time, but indicates the value of the new trace.

The marker can also be assigned to the currently active trace using the "Marker to Trace" softkey in the "Marker" menu.

If a trace is turned off, the assigned markers and marker functions are also deactivated.

Remote command:
`CALCulate<n>:MARKer<m>:TRACe` on page 627

Select Marker
The "Select Marker" function opens a dialog box to select and activate or deactivate one or more markers quickly.



Remote command:
Marker selected via suffix <m> in remote commands.

All Markers Off
Deactivates all markers in one step.

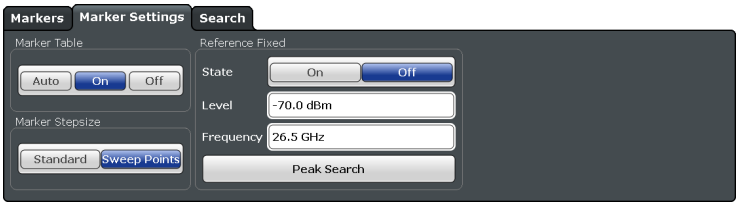
Remote command:
`CALCulate<n>:MARKer<m>:AOFF` on page 625

4.4.2.2 General Marker Settings

Some general marker settings allow you to influence the marker behavior for all markers.

These settings are located in the "Marker Settings" tab of the "Marker" dialog box. To display this tab, do one of the following:

- Press the MKR key, then select the "Marker Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker" tab. Then select the horizontal "Marker Settings" tab.



Marker Table Display 362
Marker Info 362
Marker Stepsize 362
Defining a Fixed Reference 362

Marker Table Display
Defines how the marker information is displayed.

"On" Displays the marker information in a table in a separate area beneath the diagram.

"Off" Displays the marker information within the diagram area.

"Auto" (Default) Up to two markers are displayed in the diagram area. If more markers are active, the marker table is displayed automatically.

Remote command:
`DISPlay:MTABle` on page 630

Marker Info
Turns the marker information displayed in the diagram on and off.

Remote command:
`DISPlay:MINFo[:STAT]` on page 630

Marker Stepsize
Defines the size of the steps that the marker position is moved using the rotary knob.

"Standard" The marker position is moved in (Span/1000) steps, which corresponds approximately to the number of pixels for the default display of 1001 measurement points. This setting is most suitable to move the marker over a larger distance.

"Sweep Points" The marker position is moved from one sweep point to the next. This setting is required for a very precise positioning if more sweep points are collected than the number of pixels that can be displayed on the screen. It is the default mode.

Remote command:
`CALCulate<n>:MARKer<m>:X:SSIZe` on page 629

Defining a Fixed Reference
Instead of using a reference marker that may vary its position depending on the measurement results, a fixed reference marker can be defined for trace analysis.

When you set the "State" to "On", a vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is activated and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value. The delta marker refers to the fixed reference marker.

If activated, the fixed reference marker ("FXD") can also be selected as a "Reference Marker" instead of another marker.

The "Level" and "Frequency" or "Time" settings define the position and value of the reference marker.

Alternatively, a **Peak Search** can be performed to set the current maximum value of the trace assigned to marker 1 as the fixed reference marker.

Remote command:
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed[:STATe]` on page 629
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y` on page 628
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X` on page 628
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK]` on page 628

4.4.3 Marker Search Settings and Positioning Functions

Several functions are available to set the marker to a specific position very quickly and easily, or to use the current marker position to define another characteristic value. In order to determine the required marker position, searches may be performed. The search results can be influenced by special settings.

Most marker positioning functions and the search settings are available in the MKR ➞ menu.

Search settings are also available via the MARKER key or in the vertical "Marker Config" tab of the "Analysis" dialog box (horizontal "Search Settings" tab).

For more information on searching for signal peaks see chapter 4.4.1.4, "Searching for Signal Peaks", on page 351.

The remote commands required to define these settings are described in chapter 5.8.3.3, "Marker Search", on page 630 and chapter 5.8.3.4, "Positioning Markers", on page 633.

- Marker Search Settings....363
- Marker Search Settings for Spectrograms....366
- Positioning Functions....367

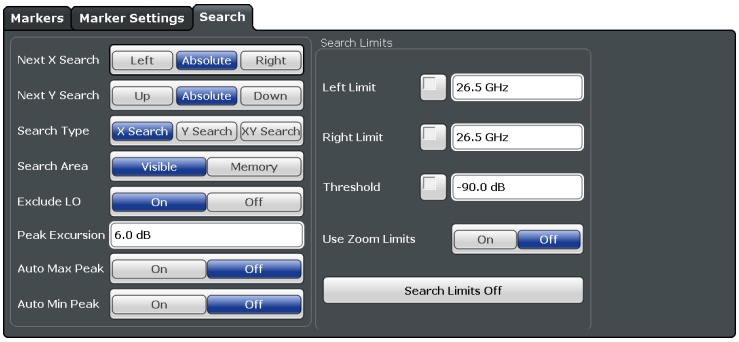
4.4.3.1 Marker Search Settings

Markers are commonly used to determine peak values, i.e. maximum or minimum values, in the measured signal. Configuration settings allow you to influence the peak search results.

For Spectrograms, special marker settings are available, see chapter 4.4.3.2, "Marker Search Settings for Spectrograms", on page 366.

These settings are are available as softkeys in the "Marker To" menu, or in the "Search Settings" tab of the "Marker" dialog box. To display this tab, do one of the following:

- Press the MKR key, then select the "Marker Config" softkey. Then select the horizontal "Search Settings" tab.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Config" tab. Then select the horizontal "Search Settings" tab.



Search Mode for Next Peak 364
Exclude LO 364
Peak Excursion 365
Auto Max / Min Peak Search 365
Search Limits 365
└ Search Limits (Left / Right) 365
└ Search Threshold 365
└ Using Zoom Limits 366
└ Deactivating All Search Limits 366

Search Mode for Next Peak
Selects the search mode for the next peak search.

"Left" Determines the next maximum/minimum to the left of the current peak.

"Absolute" Determines the next maximum/minimum to either side of the current peak.

"Right" Determines the next maximum/minimum to the right of the current peak.

Remote command:
Find a list of remote commands in chapter 5.8.3.4, "Positioning Markers", on page 633.

Exclude LO
If activated, restricts the frequency range for the marker search functions.

"ON" The minimum frequency included in the peak search range is ≥ 5 × resolution bandwidth (RBW).
Due to the interference by the first local oscillator to the first intermediate frequency at the input mixer, the LO is represented as a signal at 0 Hz. To avoid the peak marker jumping to the LO signal at 0 Hz, this frequency is excluded from the peak search.

"OFF" No restriction to the search range. The frequency 0 Hz is included in the marker search functions.

Remote command:
`CALCulate<n>:MARKer<m>:LOEXclude` on page 631

Peak Excursion
Defines the minimum level value by which a signal must rise or fall so that it will be identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For more information see chapter 4.4.1.4, "Searching for Signal Peaks", on page 351.

Remote command:
`CALCulate<n>:MARKer<m>:PEXCursion` on page 631

Auto Max / Min Peak Search
If activated, a maximum or minimum peak search is performed automatically for marker 1 after each measurement.

For spectrogram displays, define which frame the peak is to be searched in.

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum:AUTO` on page 636
`CALCulate<n>:MARKer<m>:MINimum:AUTO` on page 637

Search Limits
The search results can be restricted by limiting the search area or adding search conditions.

Search Limits (Left / Right) ← Search Limits
If activated, limit lines are defined and displayed for the search. Only results within the limited search range are considered.

For details on limit lines for searches see "Peak search limits" on page 351.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 632
`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 631
`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT` on page 632

Search Threshold ← Search Limits
Defines an absolute threshold as an additional condition for the peak search. Only peaks that exceed the threshold are detected.

Remote command:
`CALCulate<n>:THReshold` on page 633

Using Zoom Limits ← Search Limits
If activated, the peak search is restricted to the active zoom area defined for a single zoom (see "Single Zoom" on page 310).

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe]` on page 632

Deactivating All Search Limits ← Search Limits
Deactivates the search range limits.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 632
`CALCulate<n>:THReshold:STATe` on page 633

4.4.3.2 Marker Search Settings for Spectrograms

Spectrograms show not only the current sweep results, but also the sweep history. Thus, when searching for peaks, you must define the search settings within a single time frame (x-direction) and within several time frames (y-direction).

These settings are only available for spectrogram displays.

These settings are are available in the "Search Settings" tab of the "Marker" dialog box. To display this tab, do one of the following:

- Press the MKR key, then select the "Marker Config" softkey. Then select the horizontal "Search Settings" tab.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Config" tab. Then select the horizontal "Search Settings" tab.

Functions for marker search in spectrograms described elsewhere:

- "Exclude LO" on page 364
- "Peak Excursion" on page 365
- "Auto Max / Min Peak Search" on page 365
- "Search Limits (Left / Right)" on page 95
- "Search Threshold" on page 365
- "Using Zoom Limits" on page 366
- "Deactivating All Search Limits" on page 95

Search Mode for Next Peak in X Direction....366
Search Mode for Next Peak in Y Direction....367
Marker Search Type....367
Marker Search Area....367

Search Mode for Next Peak in X Direction
Selects the search mode for the next peak search within the currently selected frame.

"Left" Determines the next maximum/minimum to the left of the current peak.

"Absolute" Determines the next maximum/minimum to either side of the current peak.

"Right" Determines the next maximum/minimum to the right of the current peak.

Remote command:
Find a list of remote commands in chapter 5.8.3.6, "Using Markers in Spectrograms", on page 640.

Search Mode for Next Peak in Y Direction
Selects the search mode for the next peak search within all frames at the current marker position.

"Up" Determines the next maximum/minimum above the current peak (in more recent frames).

"Absolute" Determines the next maximum/minimum above or below the current peak (in all frames).

"Down" Determines the next maximum/minimum below the current peak (in older frames).

Remote command:
Find a list of remote commands in chapter 5.8.3.6, "Using Markers in Spectrograms", on page 640.

Marker Search Type
Defines the type of search to be performed in the spectrogram.

"X-Search" Searches only within the currently selected frame.

"Y-Search" Searches within all frames but only at the current frequency position.

"XY-Search" Searches in all frames at all positions.

Remote command:
Find a list of remote commands in chapter 5.8.3.6, "Using Markers in Spectrograms", on page 640.

Marker Search Area
Defines which frames the search is performed in.

"Visible" Only the visible frames are searched.

"Memory" All frames stored in the memory are searched.

Remote command:
`CALCulate<n>:MARKer<m>:SPECtrogram:SAREa` on page 641
`CALCulate<n>:DELTamarker<m>:SPECtrogram:SAREa` on page 645

4.4.3.3 Positioning Functions

The following functions set the currently selected marker to the result of a peak search or set other characteristic values to the current marker value.

These functions are available as softkeys in the "Marker To" menu, which is displayed when you press the MKR → key.

Peak Search....368
Search Next Peak....368
Search Minimum....368
Search Next Minimum....368
Center Frequency = Marker Frequency....369
Reference Level = Marker Level....369

Peak Search
Sets the selected marker/delta marker to the maximum of the trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the peak is to be searched in.

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 637
`CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 634

Search Next Peak
Sets the selected marker/delta marker to the next (lower) maximum of the assigned trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the next peak is to be searched in.

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 636
`CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 636
`CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 636
`CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 634
`CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt` on page 634
`CALCulate<n>:DELTamarker<m>:MAXimum:LEFT` on page 634

Search Minimum
Sets the selected marker/delta marker to the minimum of the trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the minimum is to be searched in.

Remote command:
`CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 638
`CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 635

Search Next Minimum
Sets the selected marker/delta marker to the next (higher) minimum of the selected trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the next minimum is to be searched in.

Remote command:
`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 637
`CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 637
`CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 638
`CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 635
`CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 635
`CALCulate<n>:DELTamarker<m>:MINimum:RIGHt` on page 635

Center Frequency = Marker Frequency
Sets the center frequency to the selected marker or delta marker frequency. A peak can thus be set as center frequency, for example to analyze it in detail with a smaller span.

This function is not available for zero span measurements.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:CENTer` on page 573

Reference Level = Marker Level
Sets the reference level to the selected marker level.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:REFerence` on page 575

4.4.4 Marker Function Configuration

Special marker functions can be selected via the "Marker Function" dialog box.

To display this dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab.

The remote commands required to define these settings are described in chapter 5.8.3.7, "Marker Functions", on page 647.

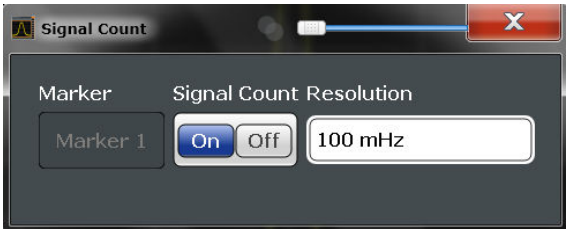
- Precise Frequency (Signal Count) Marker....370
- Noise Measurement Marker....371
- Phase Noise Measurement Marker....372
- n dB Down Marker....373
- Reference Fixed....374
- Band Power Marker....375
- Marker Peak List Configuration....376
- Deactivating All Marker Functions....378

4.4.4.1 Precise Frequency (Signal Count) Marker

A special marker can be used to determine a particular frequency or time in a measured signal very accurately. Signal counters are configured in the "Signal Count Config" dialog box.

To display the "Signal Count Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Signal Count" button. Select the "Signal Count Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Signal Count" button. Select the "Signal Count Config" softkey.



For details see chapter 4.4.1.5, "Performing a Highly Accurate Frequency Measurement (Signal Count)", on page 353. A measurement example is described in chapter 2.2.2.2, "Measuring the Signal Frequency Using the Signal Counter", on page 20.

Signal counters are not available for measurements on I/Q-based data.

Signal Count Marker State 370
Resolution 370

Signal Count Marker State
Activates or deactivates the special signal count marker function.

When activated, the sweep stops at the reference marker until the signal counter has delivered a result.

Remote command:
`CALCulate<n>:MARKer<m>:COUNt` on page 647
`CALCulate<n>:MARKer<m>:COUNt:FREQuency?` on page 648

Resolution
Defines the resolution with which the signal is analyzed around the reference marker 1.

Remote command:
`CALCulate<n>:MARKer<m>:COUNt:RESolution` on page 648

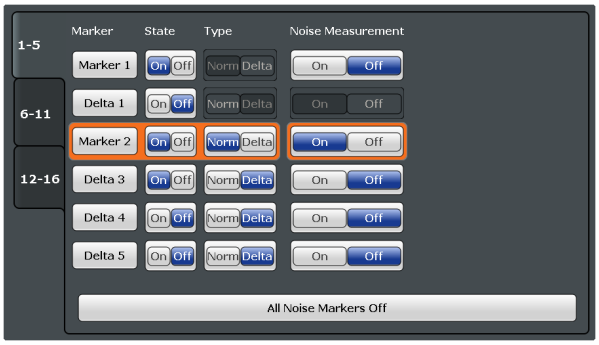
4.4.4.2 Noise Measurement Marker

For each of the 16 markers noise measurement can be activated. Noise measurement markers are configured in the "Noise Measurement Config" dialog box, using the "Noise Measurement" function.

The individual marker settings correspond to those defined in the "Marker" dialog box (see chapter 4.4.2.1, "Individual Marker Setup", on page 359). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.

To display the "Noise Measurement Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Noise Measurement" button. Select the "Noise Meas Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Noise Measurement" button. Select the "Noise Meas Config" softkey.



For details see chapter 4.4.1.7, "Measuring Noise Density", on page 354.

Marker State....371
Marker Type....371
Noise Measurement State....372
Switching All Noise Measurements Off....372

Marker State
Activates or deactivates the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 626
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 624

Marker Type
Toggles the marker type.

The type for marker 1 is always "Normal", the type for delta marker 1 is always "Delta". These types cannot be changed.

Note: If normal marker 1 is the active marker, switching the "Mkr Type" activates an additional delta marker 1. For any other marker, switching the marker type does not activate an additional marker, it only switches the type of the selected marker.

"Normal" A normal marker indicates the absolute value at the defined position in the diagram.

"Delta" A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
CALCulate<n>:MARKer<m>[:STATe] on page 626
CALCulate<n>:DELTamarker<m>[:STATe] on page 624

Noise Measurement State
Activates or deactivates noise measurement for the marker in the diagram.

This function is only available for normal markers.

If activated, the marker displays the noise power density measured at the position of the marker.

For details see chapter 4.4.1.7, "Measuring Noise Density", on page 354.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe] on page 649
CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult? on page 649

Switching All Noise Measurements Off
Deactivates noise measurement for all markers.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe] on page 649

4.4.4.3 Phase Noise Measurement Marker

Access: "Overview" > "Analysis" > "Marker Functions" > "Phase Noise" > "Phase Noise Config"

For each of the 16 markers phase noise measurement can be activated.

The individual marker settings correspond to those defined in the "Marker" dialog box. Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.

For more information see chapter 4.4.1.8, "Measuring Phase Noise", on page 355.

Phase Noise Measurement State 373
Defining a Reference Point 373
Switching All Phase Noise Measurements Off 373

Phase Noise Measurement State
Activates or deactivates phase noise measurement for the reference point in the diagram.

This function is only available for delta markers.

If activated, the delta markers display the phase noise measured at defined offsets from the reference position.

Remote command:
`CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe]` on page 650
`CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult?` on page 650

Defining a Reference Point
Instead of using marker 1 as the reference marker, a fixed reference marker can be defined for phase noise measurement.

The "Level" and "Frequency" or "Time" settings define the position and value of the reference point.

Alternatively, a **Peak Search** can be performed to set the maximum value of the selected trace as the reference point.

If "Automatic Peak Search" is activated, a peak search is started automatically after each sweep and the result is used as the reference point.

Remote command:
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y` on page 628
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X` on page 628
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK]` on page 628
`CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:AUTO` on page 650

Switching All Phase Noise Measurements Off
Deactivates phase noise measurement for all markers.

Remote command:
`CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe]` on page 650

4.4.4.4 n dB Down Marker

Access: "Overview" > "Analysis" > "Marker" > "Marker Functions" > "n dB down" > "n dB Down Config"

A special marker can be defined to determine a characteristic bandwidth or time span in a measured signal.

For details see chapter 4.4.1.9, "Measuring Characteristic Bandwidths (n dB Down Marker)", on page 356.

n dB down Marker State....374
n dB down Delta Value....374

n dB down Marker State
Activates or deactivates the special n dB down marker function.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:STATe` on page 653
`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult?` on page 653

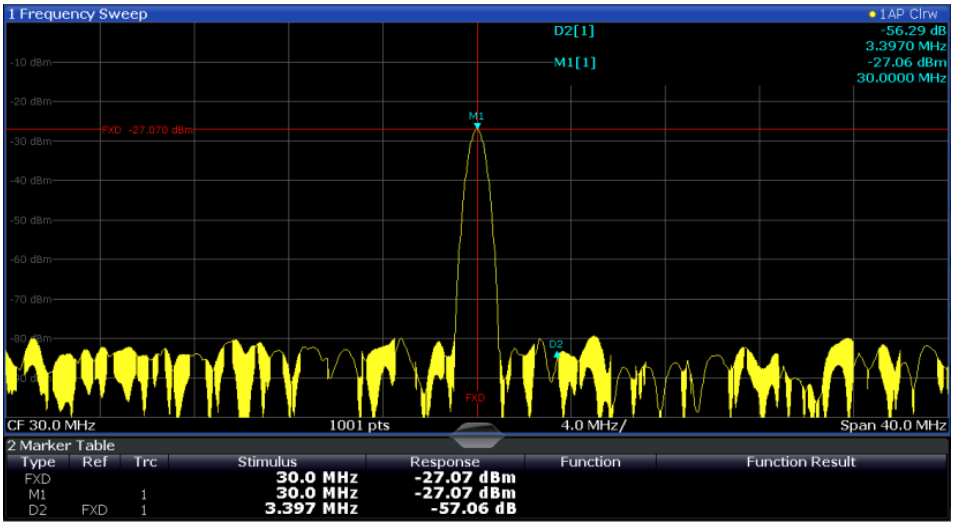
n dB down Delta Value
Defines the delta level from the reference marker 1 used to determine the bandwidth or time span.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency?` on page 652
`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:TIME?` on page 654

4.4.4.5 Reference Fixed

Instead of using a reference marker that may vary its position depending on the measurement results, a fixed reference marker can be defined for trace analysis. Once positioned, the reference marker does not move during subsequent sweeps unless you explicitely move it manually.

When you select this marker function, a vertical and a horizontal red display line are displayed, marked as "FXD". A normal marker is activated and set to the peak value and a delta marker to the next peak. The fixed reference marker is set to the position of the normal marker at the peak value. The delta marker refers to the fixed reference marker.



You can move the position of the fixed reference marker graphically by dragging the display lines, or numerically by entering values for the marker position and level.

For more information see chapter 4.4.1.6, "Defining a Fixed Reference Marker", on page 353.

4.4.4.6 Band Power Marker

Access: "Overview" > "Analysis" > "Marker Functions" > "Band Power" > "Band Power Config"

For each of the 16 markers band power measurement can be activated.

The individual marker settings correspond to those defined in the "Marker" dialog box (see chapter 4.4.2.1, "Individual Marker Setup", on page 359). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.

For more information see chapter 4.4.1.10, "Measuring the Power in a Channel (Band)", on page 357.

Band Power Measurement State 375
Span 376
Power Mode 376
Switching All Band Power Measurements Off 376

Band Power Measurement State
Activates or deactivates band power measurement for the marker in the diagram.

Band power markers are only available for standard frequency measurements (not zero span) in the Spectrum application.

If activated, the markers display the power or density measured in the band around the current marker position.

For details see chapter 4.4.1.10, "Measuring the Power in a Channel (Band)", on page 357.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe]` on page 657
`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe]` on page 655

Span
Defines the span (band) around the marker for which the power is measured. The span is indicated by lines in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN` on page 656
`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:SPAN` on page 655

Power Mode
Defines the mode of the power measurement result.

"Power" The result is an absolute power level. The power unit depends on the Unit setting.

"Density" The result is a power level in relation to the bandwidth, displayed in dBm/Hz.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE` on page 656
`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE` on page 655

Switching All Band Power Measurements Off
Deactivates band power measurement for all markers.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe]` on page 657
`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe]` on page 655

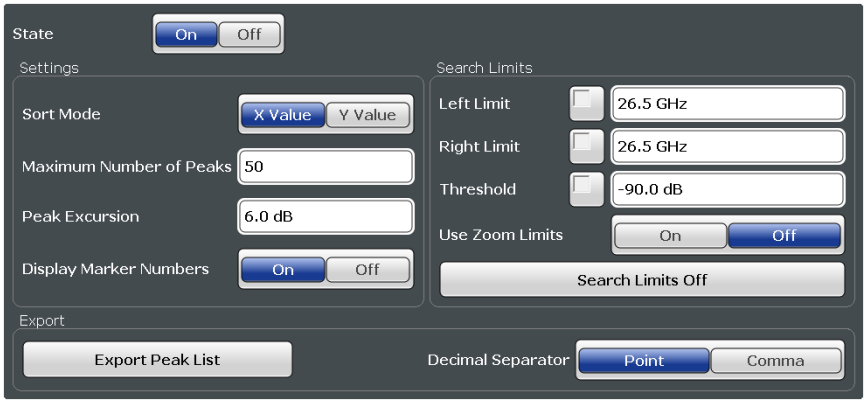
4.4.4.7 Marker Peak List Configuration

Access: "Overview" > "Analysis" > "Marker" > "Marker Functions" > "Marker Peak List" > "Peak List"

The marker peak list provides an overview of all marker peaks in the measurement. You can define search and sort criteria to influence the results of the analysis. The general marker search settings also apply to the marker peak list.

For more information see chapter 4.4.1.4, "Searching for Signal Peaks", on page 351 and chapter 4.4.3, "Marker Search Settings and Positioning Functions", on page 363.

The individual marker settings correspond to those defined in the "Marker" dialog box (see chapter 4.4.2, "Marker Settings", on page 358). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.



Peak List State....377
Sort Mode....377
Maximum Number of Peaks....377
Peak Excursion....377
Displaying Marker Numbers....378
Exporting the Peak List....378

Peak List State
Activates/deactivates the marker peak list. If activated, the peak list is displayed and the peaks are indicated in the trace display.

For each listed peak the frequency/time ("X-value") and level ("Y-value") values are given.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe` on page 659

Sort Mode
Defines whether the peak list is sorted according to the x-values or y-values. In either case the values are sorted in ascending order.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT` on page 658

Maximum Number of Peaks
Defines the maximum number of peaks to be determined and displayed.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE` on page 658

Peak Excursion
Defines the minimum level value by which a signal must rise or fall so that it will be identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For more information see chapter 4.4.1.4, "Searching for Signal Peaks", on page 351.

Remote command:
`CALCulate<n>:MARKer<m>:PEXCursion` on page 631

Displaying Marker Numbers
By default, the marker numbers are indicated in the diagram so you can find the peaks from the list. However, for large numbers of peaks the marker numbers may decrease readability; in this case, deactivate the marker number display.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe]` on page 657

Exporting the Peak List
The peak list can be exported to an ASCII file (`.DAT`) for analysis in an external application.

Remote command:
`MMEMory:STORe<n>:PEAK` on page 659
`FORMat:DEXPort:DSEParator` on page 615

4.4.4.8 Deactivating All Marker Functions

All special marker functions can be deactivated in one step.

Use the "All Functions Off" button in the "Marker Functions" dialog box.

4.4.5 How to Work With Markers

The following step-by-step instructions demonstrate in detail how to work with markers.

- How to Analyze a Signal Point in Detail....378
- How to Use a Fixed Reference Marker....379

4.4.5.1 How to Analyze a Signal Point in Detail

Step-by-step instructions on working with markers are provided here. For details on individual functions and settings see chapter 4.4.2, "Marker Settings", on page 358.

The remote commands required to perform these tasks are described in chapter 5.8.3, "Marker Usage", on page 622.

When you need to analyze a characteristic point in the signal in more detail, the following procedure can be helpful:

1. Perform a peak search to determine the characteristic point roughly by pressing the PEAK SEARCH key.
2. If the required signal point is not the maximum, continue the peak search to one of the subsequent maxima or minima:
   a) Press the MKR -> key.
   b) Select the "Next Peak" or "Next Min" key.

c) If necessary, change the search settings by selecting the "Search Config" softkey.

3. Center the display around the determined signal point by setting the marker value to the center frequency. Select the "Center = Mkr Freq" softkey.
4. Determine the precise frequency of the signal point:
   a) Select the "Select Marker Function" softkey.
   b) Select the "Signal Count" button.
   c) Select the "Signal Count Resolution" softkey.
   d) Select the resolution depending on how precise the result needs to be.

4.4.5.2 How to Use a Fixed Reference Marker

By default, delta markers refer to marker 1. However, they can also refer to a fixed reference marker.

How to Define and Move a Fixed Reference Marker

1. To display a fixed reference marker, do one of the following:
   - Press the MKR FUNC key, then select the "Reference Fixed" marker function.
   - In the "Marker" dialog box, in the "Reference Fixed" area of the "Marker Config" tab, set the "State" to "On".

   A vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is activated and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value.
2. To move the fixed reference marker, do one of the following:
   - Change the "Level" and "Frequency" of the reference point in the "Marker Config" tab of the "Marker" dialog box, . By default, the current peak value of trace 1 is set.
   - Set the fixed reference marker to the current peak value by selecting the "Peak Search" button in the "Marker Config" tab of the "Marker" dialog box.
   - Move the "FXD" display lines that define the position of the fixed reference marker by dragging them on the screen.

How to Assign a Fixed Reference Marker to Delta Markers

1. In the "Marker" dialog box, select the horizontal "Markers" tab.
2. For the active delta marker that is to refer to the fixed reference marker, select "FXD" from the "Ref. Marker" list.

   The delta marker indicates the offset of the current trace value at the marker position from the fixed reference value.

4.4.6 Measurement Example: Measuring Harmonics Using Marker Functions

This measurement example describes how to measure harmonics using the provided marker functions. Note that this task can be performed much simpler using the Harmonic Distortion measurement (see chapter 2.10, "Harmonic Distortion Measurement", on page 173).

Signal generator settings (e.g. R&S FSWP SMW):

Frequency:	128 MHz
Level:	- 25 dBm

Procedure:

1. Preset the R&S FSWP.
2. Set the center frequency to *128 MHz*.
3. Set the span to *100 kHz*.

   The R&S FSWP displays the reference signal with a span of 100 kHz and resolution bandwidth of 1 kHz.
4. Switch on the marker by pressing the MKR key.
   The marker is positioned on the trace maximum.
5. Set the measured signal frequency and the measured level as reference values:

   a) Press the MKR FUNC key
   b) Press the "Reference Fixed" softkey.

   The position of the marker becomes the reference point. The reference point level is indicated by a horizontal line, the reference point frequency with a vertical line. At the same time, the delta marker 2 is switched on.

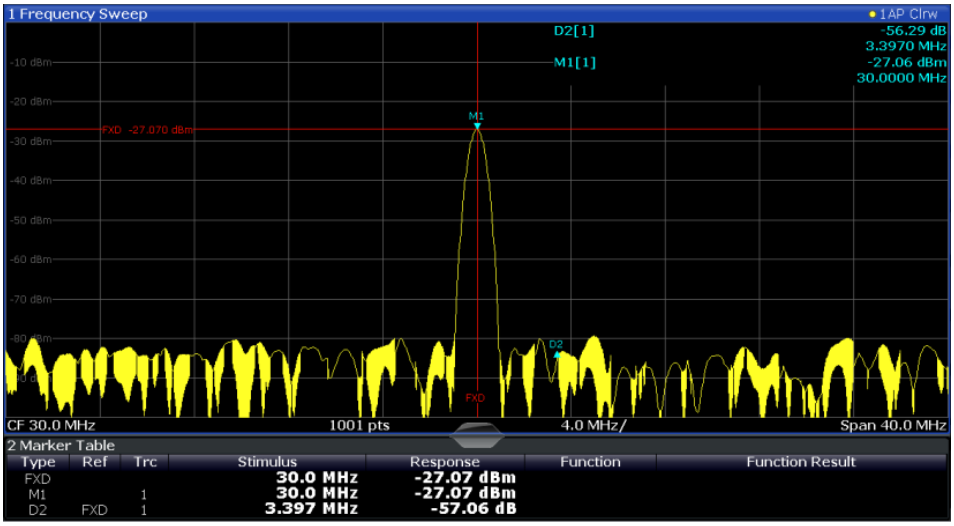


Fig. 4-16: Fundamental wave and the frequency and level reference point

6. Make the step size for the center frequency correspond to the signal frequency: in the "Frequency" configuration dialog box, select "Center Frequency Stepsize = Marker".

   The step size for the center frequency is now equal to the marker frequency.

7. Move the center frequency to the 2nd harmonic of the signal by pressing the UP (⇧) key.

   The center frequency is set to the 2nd harmonic.

8. Place the delta marker on the 2nd harmonic: in the "Marker To" menu, select the "Peak" softkey.

   The delta marker moves to the maximum of the 2nd harmonic. The displayed level result is relative to the reference point level (= fundamental wave level).

The other harmonics are measured by repeating steps step 7 and step 8, with the center frequency being incremented or decremented in steps of 128 MHz using the UP or DOWN keys.

4.5 Display and Limit Lines

Display and limit lines help you analyze a measurement trace.

- Basics on Display Lines 382
- Basics on Limit Lines 382
- Settings and Functions for Display and Limit Lines 386
- How to Work with Display and Limit Lines 392

4.5.1 Basics on Display Lines

Display lines help you analyze a trace – as do markers. The function of a display line is comparable to that of a ruler that can be shifted on the trace in order to mark absolute values. They are used exclusively to visually mark relevant frequencies or points in time (zero span), as well as constant level values. It is not possible to check automatically whether the points are below or above the marked level values - use limit lines for that task (see chapter 4.5.2, "Basics on Limit Lines", on page 382).

Two different types of display lines are provided:

- Two horizontal level lines for marking levels – Display Line 1 and 2
  The level lines are continuous horizontal lines across the entire width of a diagram and can be shifted in y direction.
- Two vertical frequency or time lines for marking frequencies or points in time – Frequency/Time Line 1 and 2
  The frequency or time lines are continuous vertical lines across the entire height of the diagram and can be shifted in x direction.

Lables

Each line is identified by one of the following abbreviations in the diagrams:

- D1: Display Line 1
- D2: Display Line 2
- F1: Frequency Line 1
- F2: Frequency Line 2
- T1: Time Line 1
- T2: Time Line 2

4.5.2 Basics on Limit Lines

Limit lines are used to define amplitude curves or spectral distribution boundaries in the result diagram which are not to be exceeded. They indicate, for example, the upper limits for interference radiation or spurious waves which are allowed from a device under test (DUT). When transmitting information in TDMA systems (e.g. GSM), the amplitude of the bursts in a time slot must adhere to a curve that falls within a specified tolerance band. The lower and upper limits may each be specified by a limit line. Then, the amplitude curve can be controlled either visually or automatically for any violations of the upper or lower limits (GO/NOGO test).

The R&S FSWP supports limit lines with a maximum of 200 data points. Eight of the limit lines stored in the instrument can be activated simultaneously. The number of limit lines stored in the instrument is only limited by the capacity of the storage device used.

Compatibility

Limit lines are compatible with the current measurement settings, if the following applies:

- The x unit of the limit line has to be identical to the current setting.

- The y unit of the limit line has to be identical to the current setting with the exception of dB based units; all dB based units are compatible with each other.

Validity

Only limit lines that fulfill the following conditions can be activated:

- Each limit line must consist of a minimum of 2 and a maximum of 200 data points.
- The frequencies/times for each data point must be defined in ascending order; however, for any single frequency or time, two data points may be entered (to define a vertical segment of a limit line).
- Gaps in frequency or time are not allowed. If gaps are desired, two separate limit lines must be defined and then both enabled.
- The entered frequencies or times need not necessarily be selectable in R&S FSWP. A limit line may also exceed the specified frequency or time range. The minimum frequency for a data point is -200 GHz, the maximum frequency is 200 GHz. For the time range representation, negative times may also be entered. The allowed range is -1000 s to +1000 s.

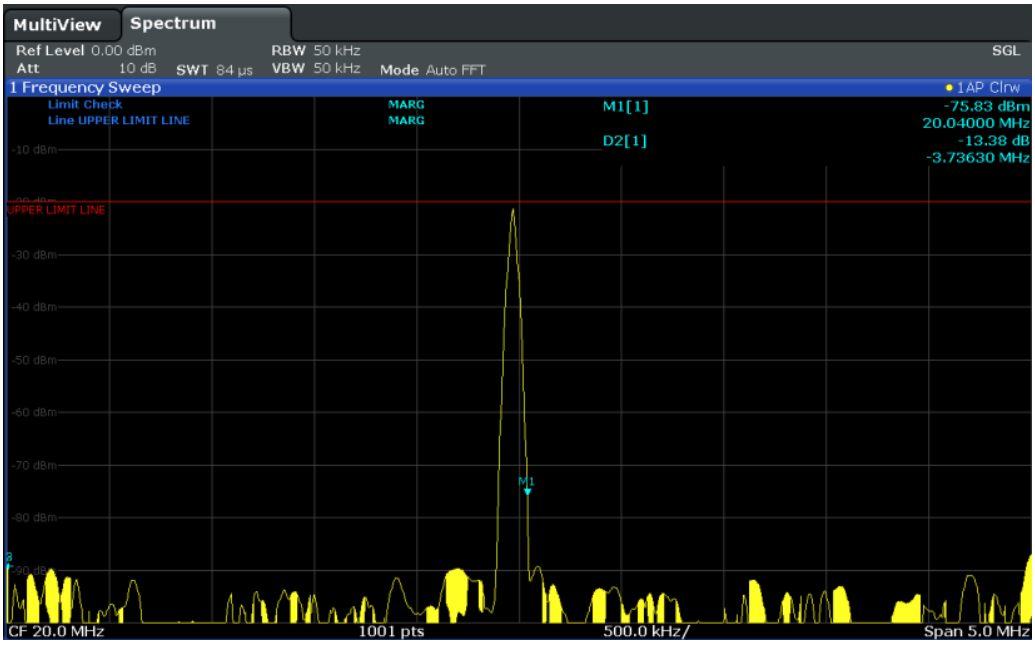


Fig. 4-17: Example for an upper limit line

Limits and Margins

Limit lines define strict values that must not be exceeded by the measured signal. A **margin** is similar to a limit, but less strict and it still belongs to the valid data range. It can be used as a warning that the limit is almost reached. The margin is not indicated by a separate line in the display, but if it is violated, a warning is displayed. Margins are defined as lines with a fixed distance to the limit line.

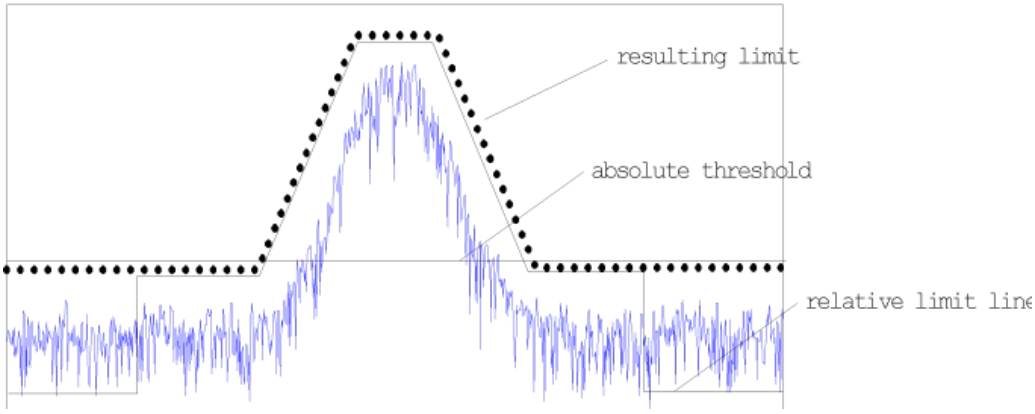
To check the signal for maximum levels you must define an **upper limit**, whereas to check the signal for minimum levels you must define a **lower limit**.

Limits can be defined relative to the reference level, the beginning of the time scale, or the center frequency, or as absolute values.

Relative scaling is suitable, for example, if masks for bursts are to be defined in zero span, or if masks for modulated signals are required in the frequency domain.

Thresholds

If the y-axis for the limit line data points uses relative scaling, an additional absolute **threshold** can be defined for the limit check. In this case, both the threshold value and the relative limit line must be exceeded before a violation occurs.



Offsets and Shifting

A configured limit line can easily be moved vertically or horizontally. Two different methods to do so are available:

- An **offset** moves the entire line in the diagram without editing the configured values or positions of the individual data points. This option is only available if relative scaling is used.
  Thus, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally or vertically.
- Defining a **shift** width for the values or position of the individual data points changes the line configuration, thus changing the position of the line in the diagram.

Limit Check Results

A limit check is automatically performed as soon as any of the limit lines is activated ("Visibility" setting). Only the specified "Traces to be Checked" are compared with the active limit lines. The status of the limit check for each limit line is indicated in the diagram. If a violation occurs, the limit check status is set to "MARG" for a margin violation, or to"FAIL" for a limit violation.

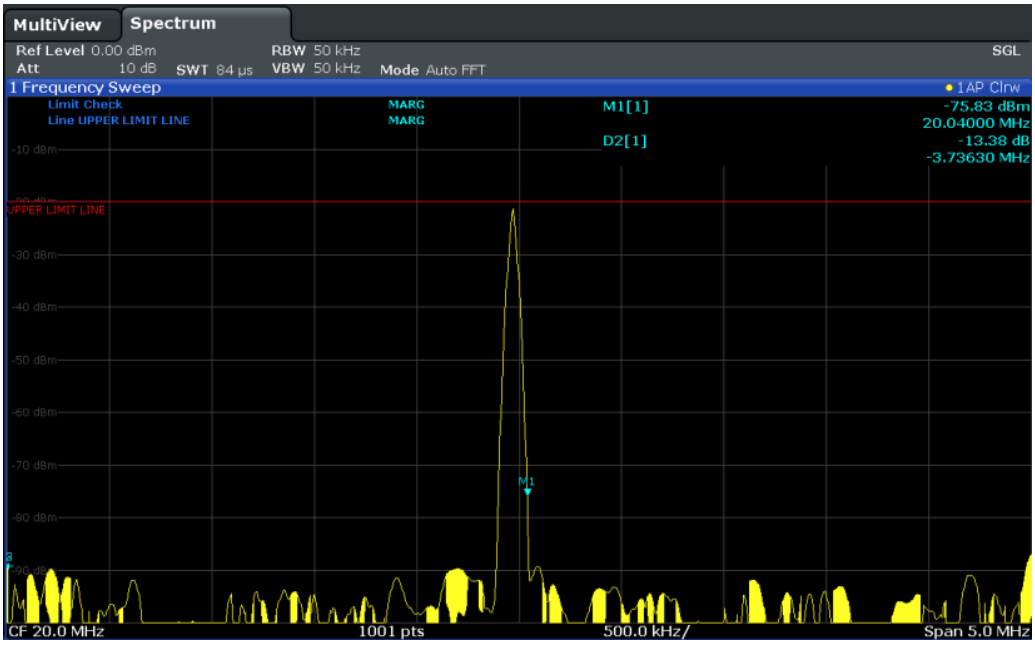


Fig. 4-18: Margin violation for limit check

Fig. 4-19: Limit violation for limit check

Storing and Recalling Limit Lines

Limit lines can be stored with the configuration settings so they can be recalled for other measurements at a later time. Note, however, that any changes made to the limit lines *after* storing the configuration file cannot be restored and will be overwritten by the stored values when the configuration file is recalled. Always remember to store the settings again after changing the limit line values.

After recalling measurement settings, the limit line values applied to the measurement may be different to those displayed in the "Limit Lines" dialog box.

For more information see the R&S FSWP User Manual, chapter "Data Management".

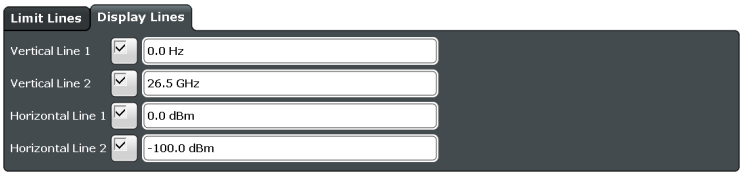
4.5.3 Settings and Functions for Display and Limit Lines

For remote operation, see chapter 5.8.4, "Lines", on page 660.

- Display Line Settings....386
- Limit Line Settings and Functions....387

4.5.3.1 Display Line Settings

Two vertical and two horizontal lines can be defined in the display.



Vertical Line 1/2.... 386
Horizontal Line 1/2.... 386

Vertical Line 1/2

Activates a vertical display line (F1/F2 or T1/T2) in the diagram at the specified frequency or point in time, depending on the frequency span.

Remote command:

`CALCulate<n>:FLINe<k>` on page 660
`CALCulate<n>:FLINe<k>` on page 660
`CALCulate<n>:TLINe<k>` on page 661
`CALCulate<n>:TLINe<k>` on page 661

Horizontal Line 1/2

Activates a horizontal display line (D1/D2) in the diagram at the specified level.

Remote command:

`CALCulate<n>:DLINe<k>` on page 660
`CALCulate<n>:DLINe<k>` on page 660

4.5.3.2 Limit Line Settings and Functions

Access: "Overview" > "Analysis" > "Lines"

Up to 8 limit lines can be displayed simultaneously in the R&S FSWP. Many more can be stored on the instrument.

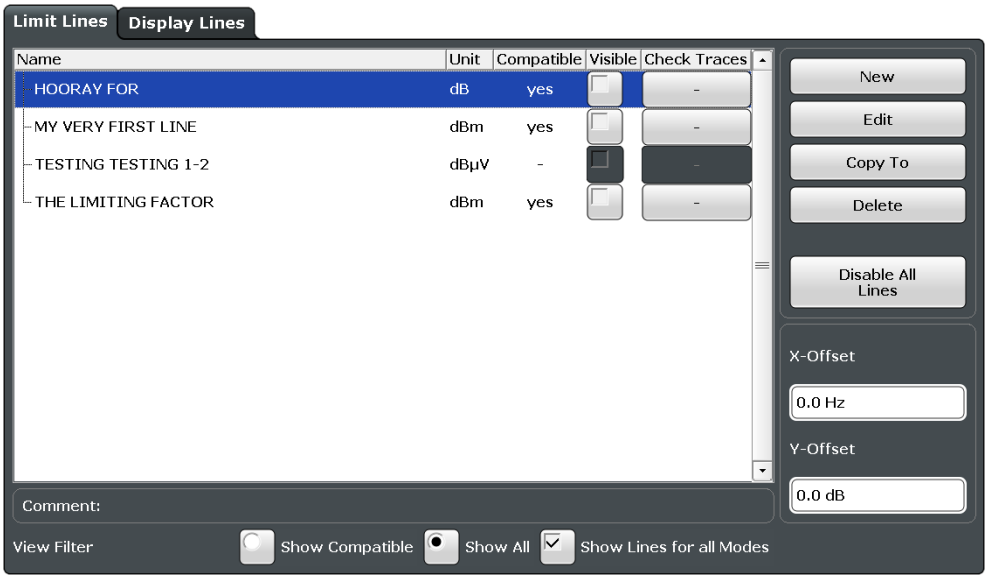
Stored limit line settings
When storing and recalling limit line settings, consider the information provided in the Data Management chapter of the R&S FSWP User Manual.

- Limit Line Management.....387
- Limit Line Details.....390

Limit Line Management

Access to limit line settings

► "Overview" > "Analysis" > "Lines" > "Limit Lines"



For the limit line overview, the R&S FSWP searches for all stored limit lines with the file extension `.LIN` in the `limits` subfolder of the main installation folder. The overview allows you to determine which limit lines are available and can be used for the current measurement.

For details on settings for individual lines see "Limit Line Details" on page 390.

For more basic information on limit lines see chapter 4.5.2, "Basics on Limit Lines", on page 382.

Name.....388
Unit.....388
Compatibility.....388

Visibility 388
Traces to be Checked 388
Comment 388
Included Lines in Overview (View Filter) 388
└ Show lines for all modes 389
X-Offset 389
Y-Offset 389
Create New Line 389
Edit Line 389
Copy Line 389
Delete Line 389
Disable All Lines 390

Name
The name of the stored limit line.

Unit
The unit in which the y-values of the data points of the limit line are defined.

Compatibility
Indicates whether the limit line definition is compatible with the current measurement settings.

For more information on which conditions a limit line must fulfill to be compatible, see "Compatibility" on page 382.

Visibility
Displays or hides the limit line in the diagram. Up to 8 limit lines can be visible at the same time. Inactive limit lines can also be displayed in the diagram.

Remote command:
`CALCulate<n>:LIMit<k>:LOWer:STATe` on page 668
`CALCulate<n>:LIMit<k>:UPPer:STATe` on page 672
`CALCulate<n>:LIMit<k>:ACTive?` on page 662

Traces to be Checked
Defines which traces are automatically checked for conformance with the limit lines. As soon as a trace to be checked is defined, the assigned limit line is active. One limit line can be activated for several traces simultaneously. If any of the "Traces to be Checked" violate any of the active limit lines, a message is indicated in the diagram.

Remote command:
`CALCulate<n>:LIMit<k>:TRACe<t>:CHECk` on page 669

Comment
An optional description of the limit line.

Included Lines in Overview (View Filter)
Defines which of the stored lines are included in the overview.

"Show compatible"	Only compatible lines Whether a line is compatible or not is indicated in the Compatibility setting.
"Show all"	All stored limit lines with the file extension `.LIN` in the `limits` subfolder of the main installation folder (if not restricted by "Show lines for all modes" setting).

Show lines for all modes ← Included Lines in Overview (View Filter)
If activated (default), limit lines from all applications are displayed. Otherwise, only lines that were created in the Spectrum application are displayed.

Note that limit lines from some applications may include additional properties that are lost when the limit lines are edited in the Spectrum application. In this case a warning is displayed when you try to store the limit line.

X-Offset
Shifts a limit line that has been specified for relative frequencies or times (x-axis) horizontally.

This setting does not have any effect on limit lines that are defined by absolute values for the x-axis.

Remote command:
`CALCulate<n>:LIMit<k>:CONTrol:OFFSet` on page 664

Y-Offset
Shifts a limit line that has relative values for the y-axis (levels or linear units such as volt) vertically.

This setting does not have any effect on limit lines that are defined by absolute values for the y-axis.

Remote command:
`CALCulate<n>:LIMit<k>:LOWer:OFFSet` on page 667
`CALCulate<n>:LIMit<k>:UPPer:OFFSet` on page 671

Create New Line
Creates a new limit line.

Edit Line
Edit an existing limit line configuration.

Copy Line
Copy the selected limit line configuration to create a new line.

Remote command:
`CALCulate<n>:LIMit<k>:COPY` on page 665

Delete Line
Delete the selected limit line configuration.

Remote command:
`CALCulate<n>:LIMit<k>:DELete` on page 665

Disable All Lines

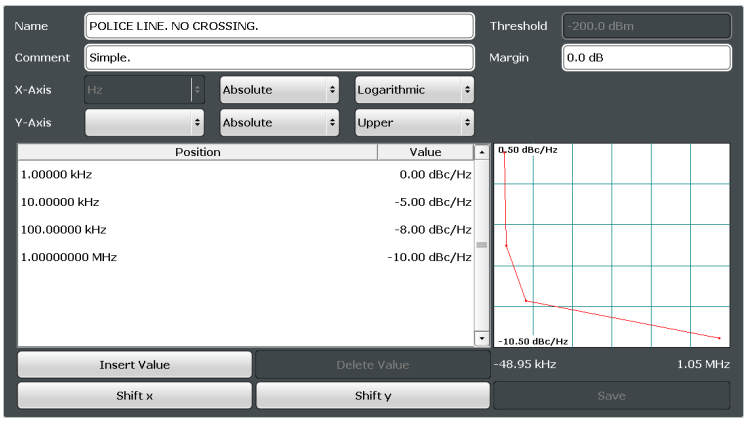
Disable all limit lines in one step.

Remote command:
CALCulate<n>:LIMit<k>:STATe on page 668

Limit Line Details

Access to limit line design

► "Overview" > "Analysis" > "Lines" > "Limit Lines" > "New" / "Edit" / "Copy To"



Name....390
Comment....390
Threshold....391
Margin....391
X-Axis....391
Y-Axis....391
Data points....392
Insert Value....392
Delete Value....392
Shift x....392
Shift y....392
Save....392

Name

Defines the limit line name. All names must be compatible with Windows conventions for file names. The limit line data is stored under this name (with a `.LIN` extension).

Remote command:
CALCulate<n>:LIMit<k>:NAME on page 668

Comment

Defines an optional comment for the limit line. The text may contain up to 40 characters.

Remote command:
CALCulate<n>:LIMit<k>:COMMent on page 663

Threshold
Defines an absolute threshold value (only for relative scaling of the y-axis).

For details on thresholds see "Thresholds" on page 384.

Remote command:
CALCulate<n>:LIMit<k>:LOWer:THReshold on page 668
CALCulate<n>:LIMit<k>:UPPer:THReshold on page 672

Margin
Defines a margin for the limit line. The default setting is 0 dB (i.e. no margin).

For details on margins see "Limits and Margins" on page 383.

Remote command:
CALCulate<n>:LIMit<k>:LOWer:MARGin on page 666
CALCulate<n>:LIMit<k>:UPPer:MARGin on page 670

X-Axis
Describes the horizontal axis on which the data points of the limit line are defined.
Includes the following settings:

- Domain:
  – "Hz": for frequency domain
  – "s": for time domain
- Scaling mode: absolute or relative (Hz/s/%) values
  For relative values, the frequencies are referred to the currently set center frequency. In the zero span mode, the left boundary of the diagram is used as the reference.
- Scaling: linear or logarithmic

Remote command:
CALCulate<n>:LIMit<k>:LOWer:SPACing on page 667
CALCulate<n>:LIMit<k>:UPPer:SPACing on page 671
CALCulate<n>:LIMit<k>:LOWer:MODE on page 666
CALCulate<n>:LIMit<k>:UPPer:MODE on page 670
CALCulate<n>:LIMit<k>:CONTrol:DOMain on page 663

Y-Axis
Describes the vertical axis on which the data points of the limit line are defined.
Includes the following settings:

- Level unit
- Scaling mode: absolute or relative (dB/%) values
  Relative limit values refer to the reference level.
- Limit type: upper or lower limit; values must stay above the lower limit and below the upper limit to pass the limit check

Remote command:
CALCulate<n>:LIMit<k>:UNIT on page 669
CALCulate<n>:LIMit<k>:LOWer:SPACing on page 667
CALCulate<n>:LIMit<k>:UPPer:SPACing on page 671

Data points
Each limit line is defined by a minimum of 2 and a maximum of 200 data points. Each data point is defined by its position (x-axis) and value (y-value). Data points must be defined in ascending order. The same position can have two different values.

Remote command:
`CALCulate<n>:LIMit<k>:CONTrol[:DATA]` on page 663
`CALCulate<n>:LIMit<k>:LOWer[:DATA]` on page 666
`CALCulate<n>:LIMit<k>:UPPer[:DATA]` on page 670

Insert Value
Inserts a data point in the limit line above the selected one in the "Edit Limit Line" dialog box.

Delete Value
Deletes the selected data point in the "Edit Limit Line" dialog box.

Shift x
Shifts the x-value of each data point horizontally by the defined shift width (as opposed to an additive offset defined for the entire limit line, see "X-Offset" on page 389).

Remote command:
`CALCulate<n>:LIMit<k>:CONTrol:SHIFt` on page 664

Shift y
Shifts the y-value of each data point vertically by the defined shift width (as opposed to an additive offset defined for the entire limit line, see "Y-Offset" on page 389).

Remote command:
`CALCulate<n>:LIMit<k>:LOWer:SHIFt` on page 667
`CALCulate<n>:LIMit<k>:UPPer:SHIFt` on page 671

Save
Saves the currently edited limit line under the name defined in the "Name" field.

4.5.4 How to Work with Display and Limit Lines

Step-by-step instructions on configuring display and limit lines are provided here. For details on individual functions and settings see chapter 4.5.3, "Settings and Functions for Display and Limit Lines ", on page 386.

4.5.4.1 Defining Display Lines

1. Display lines are configured in the "Lines Config" dialog box. To display this dialog box, press the LINES key and then "Lines Config".
2. Select the "Display Lines" tab.
3. To define a vertical line, select "Vertical Line 1" or 2 and enter the x-value at which the line is to be displayed.

To define a horizontal line, select "Horizontal Line 1" or 2 and enter the y-value at which the line is to be displayed.

4.5.4.2 Defining Limit Lines

Limit lines are configured in the "Lines Config" dialog box. To display this dialog box, do one of the following:

- Press the LINES key and then the "Lines Config" softkey, then select the "Lines Config" tab.
- In the "Overview", select "Analysis" and then the vertical "Limit Lines Config" tab.

Limit lines for spurious and SEM measurements

Note that for spurious and SEM measurements, special limit lines can be defined for each frequency range, see chapter 2.6.4.2, "Limit Lines in SEM Measurements", on page 104 and chapter 2.7.3.2, "Limit Lines in Spurious Measurements", on page 144. It is strongly recommended that you define limits only via the "Sweep list" dialog for these measurements, not using the LINES key.

Any changes to the special limit lines are automatically overwritten when the sweep list settings are changed.

The following tasks are described here:

- "How to find compatible limit lines" on page 393
- "How to activate and deactivate a limit check" on page 393
- "How to edit existing limit lines" on page 394
- "How to copy an existing limit line" on page 394
- "How to delete an existing limit line" on page 394
- "How to configure a new limit line" on page 394
- "How to move the limit line vertically or horizontally" on page 395

How to find compatible limit lines

► In the "Line Config" dialog box, select the "View filter" option: "Show compatible".

All stored limit lines with the file extension `.LIN` in the `limits` subfolder of the main installation folder of the instrument that are compatible to the current measurement settings are displayed in the overview.

How to activate and deactivate a limit check

A limit check is automatically performed as soon as any of the limit lines is activated.

1. To activate a limit check:
   Select the "Check Traces" setting for a limit line in the overview and select the trace numbers to be included in the limit check. One limit line can be assigned to several traces.

The specified traces to be checked are compared with the active limit lines. The status of the limit check is indicated in the diagram.

2. To deactivate a limit line, deactivate all "Traces to check" for it.
   To deactivate all limit lines at once, select the "Disable All Lines" button.

   The limit checks for the deactivated limit lines are stopped and the results are removed form the display.

How to edit existing limit lines

Existing limit line configurations can be edited.

1. In the "Line Config" dialog box, select the limit line.
2. Select the "Edit" button.
3. Edit the line configuration as described in "How to configure a new limit line" on page 394.
4. Save the new configuration by selecting the "Save" button.

   If the limit line is active, the edited limit line is displayed in the diagram.

How to copy an existing limit line

1. In the "Line Config" dialog box, select the limit line.
2. Select the "Copy To" button.
3. Define a new name to create a new limit with the same configuration as the source line.
4. Edit the line configuration as described in "How to configure a new limit line" on page 394.
5. Save the new configuration by selecting the "Save" button.

   The new limit line is displayed in the overview and can be activated.

How to delete an existing limit line

1. In the "Line Config" dialog box, select the limit line.
2. Select the "Delete" button.
3. Confirm the message.

   The limit line and the results of the limit check are deleted.

How to configure a new limit line

1. In the "Line Config" dialog box, select the "New" button.

   The "Edit Limit Line" dialog box is displayed. The current line configuration is displayed in the preview area of the dialog box. The preview is updated after each change to the configuration.
2. Define a "Name" and, optionally, a "Comment" for the new limit line.

3. Define the x-axis configuration:
   - Time domain or frequency domain
   - Absolute or relative limits
   - Linear or logarithmic scaling
4. Define the y-axis configuration:
   - Level unit
   - Absolute or relative limits
   - Upper or lower limit line
5. Define the data points: minimum 2, maximum 200:
   a) Select "Insert Value".
   b) Define the x-value ("Position") and y-value ("Value") of the first data point.
   c) Select "Insert Value" again and define the second data point.
   d) Repeat this to insert all other data points.
   To insert a data point before an existing one, select the data point and then "Insert Value".
   To insert a new data point at the end of the list, move the focus to the line after the last entry and then select "Insert Value".
   To delete a data point, select the entry and then "Delete Value".
6. Check the current line configuration in the preview area of the dialog box. If necessary, correct individual data points or add or delete some.
   If necessary, shift the entire line vertically or horizontally by selecting the "Shift x" or "Shift y" button and defining the shift width.
7. Optionally, define a "Margin" at a fixed distance to the limit line.
   The margin must be within the valid value range and is not displayed in the diagram or preview area.
8. Optionally, if the y-axis uses relative scaling, define an absolute "Threshold" as an additional criteria for a violation.
9. Save the new configuration by selecting the "Save" button.

   The new limit line is displayed in the overview and can be activated.

How to move the limit line vertically or horizontally

A configured limit line can easily be moved vertically or horizontally. Thus, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally.

1. In the "Line Config" dialog box, select the limit line.
2. To shift the complete limit line parallel in the horizontal direction, select the "X-Offset" button and enter an offset value.
   To shift the complete limit line parallel in the vertical direction, select the "Y-Offset" button and enter an offset value.
3. To shift the individual data points of a limit line by a fixed value (all at once):

a) Select the "Edit" button.
b) In the "Edit Limit Line" dialog box, select the "Shift x" or "Shift y" button and define the shift width.
c) Save the shifted data points by selecting the "Save" button.

If activated, the limit line is shifted in the diagram.

5 Remote Control Commands for the Spectrum Application

- Introduction 397
- Configuring and Performing Measurements 402
- Remote Commands to Select the Spectrum Application 532
- General Window Commands 536
- Working with Windows in the Display 537
- Preset 543
- Common Measurement Settings 544
- Common Analysis and Display Functions 603

5.1 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FSWP.

Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

5.1.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitely.

- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S FSWP follow the SCPI syntax rules.
- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.
- **Default unit**
  This is the unit used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

5.1.2 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

5.1.3 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

5.1.4 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

5.1.5 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

5.1.6 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

`LAYout:ADD:WINDow Spectrum,LEFT,MTABle`

Parameters may have different forms of values.

- Numeric Values....400
- Boolean....401
- Character Data....401
- Character Strings....401
- Block Data....401

5.1.6.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.
- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN

Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

5.1.6.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

5.1.6.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see chapter 5.1.2, "Long and Short Form", on page 398.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

5.1.6.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

```
INSTRument:DELete 'Spectrum'
```

5.1.6.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are

transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

5.2 Configuring and Performing Measurements

5.2.1 Performing Measurements

Useful commands to perform measurements described elsewhere:

- `INITiate<n>:ESPectrum` on page 451
- `INITiate<n>:SPURious` on page 485

ABORt 402
INITiate<n>[:IMMediate] 403
INITiate<n>:CONMeas 403
INITiate<n>:CONTinuous 404
[SENSe:]SWEep:COUNt:CURRent? 405

ABORt

This command aborts the measurement in the current measurement channel and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

For details see "Preventing Overlapping Execution" in the R&S FSWP User Manual.

To abort a sequence of measurements by the Sequencer, use the `INITiate<n>:SEQuencer:ABORt` command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel to the R&S FSWP is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

To do so, send a "Device Clear" command from the control instrument to the R&S FSWP on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`
- **RSIB**: `RSDLLibclr()`

Now you can send the ABORt command on the remote channel performing the measurement.

Example: ABOR;:INIT:IMM
Aborts the current measurement and immediately starts a new one.

Example: ABOR;*WAI
INIT:IMM
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: Event
SCPI confirmed

INITiate<n>[:IMMediate]

This command starts a (single) new measurement.

With measurement count or average count > 0, this means a restart of the corresponding number of measurements. With trace mode MAXHold, MINHold and AVERage, the previous results are reset on restarting the measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

For details on synchronization refer to the R&S FSWP User Manual, chapter "Command Sequence and Synchronization".

Suffix:
<n> irrelevant

Example: INIT:CONT OFF
Switches to single measurement mode.
DISP:WIND:TRAC:MODE AVER
Switches on trace averaging.
SWE:COUN 20
Sets the measurement counter to 20 measurements.
INIT;*WAI
Starts the measurement and waits for the end of the 20 measurements.

Usage: Event

Manual operation: See "Frequency Sweep" on page 13
See "Zero Span" on page 13
See "Single Sweep/ RUN SINGLE" on page 267

INITiate<n>:CONMeas

This command restarts a (single) measurement that has been stopped (using ABORt) or finished in single measurement mode.

The measurement is restarted at the beginning, not where the previous measurement was stopped.

As opposed to `INITiate<n>[:IMMediate]`, this command does not reset traces in maxhold, minhold or average mode. Therefore it can be used to continue measurements using maxhold or averaging functions.

Suffix:
<n> irrelevant

Example:
```
INIT:CONT OFF
```
Switches to single measurement mode.
```
DISP:WIND:TRAC:MODE AVER
```
Switches on trace averaging.
```
SWE:COUN 20
```
Setting the measurement counter to 20 measurements.
```
INIT;*WAI
```
Starts the measurement and waits for the end of the 20 measurements.
```
INIT:CONM;*WAI
```
Continues the measurement (next 20 measurements) and waits for the end.
Result: Averaging is performed over 40 measurements.

Usage: Event

Manual operation: See "Continue Single Sweep" on page 268

INITiate<n>:CONTinuous <State>

This command controls the measurement mode for an individual measurement channel.

Note that in single measurement mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous measurement mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous measurement mode in remote control, as results like trace data or markers are only valid after a single measurement end synchronization.

For details on synchronization refer to the R&S FSWP User Manual, chapter "Command Sequence and Synchronization".

If the measurement mode is changed for a measurement channel while the Sequencer is active the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

ON | 1
Continuous measurement

OFF | 0
Single measurement

*RST: 1

Example: `INIT:CONT OFF`
Switches the measurement mode to single measurement.
`INIT:CONT ON`
Switches the measurement mode to continuous measurement.

Manual operation: See "Frequency Sweep" on page 13
See "Zero Span" on page 13
See "Continuous Sweep/RUN CONT" on page 267

[SENSe:]SWEep:COUNt:CURRent?

This query returns the current number of started sweeps or measurements. This command is only available if a sweep count value is defined and the instrument is in single sweep mode.

Example: `SWE:COUNt 64`
Sets sweep count to 64
`INIT:CONT OFF`
Switches to single sweep mode
`INIT`
Starts a sweep (without waiting for the sweep end!)
`SWE:COUN:CURR?`
Queries the number of started sweeps

Usage: Query only

5.2.2 Performing a Sequence of Measurements

INITiate<n>:SEQuencer:ABORt....405
INITiate<n>:SEQuencer:IMMediate....405
INITiate<n>:SEQuencer:MODE....406
SYSTem:SEQuencer....407

INITiate<n>:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate<n>:SEQuencer:IMMediate` on page 405.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 407.

Suffix:
<n> irrelevant

Usage: Event

INITiate<n>:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer.

Its effect is similar to the `INITiate<n>[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 407).

Suffix:
<n> irrelevant

Example:
`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Usage: Event

INITiate<n>:SEQuencer:MODE <Mode>

This command selects the way the R&S FSWP application performs measurements sequentially.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 407).

A detailed programming example is provided in the R&S FSWP User Manual.

Note: In order to synchronize to the end of a sequential measurement using *OPC, *OPC? or *WAI you must use `SINGle` Sequence mode.

For details see "Command Sequence and Synchronization" the R&S FSWP User Manual.

Suffix:
<n> irrelevant

Parameters:
<Mode>

SINGle
Each measurement is performed once (regardless of the channel's sweep mode), considering each channels' sweep count, until all measurements in all active channels have been performed.

CONTinuous
The measurements in each active channel are performed one after the other, repeatedly (regardless of the channel's sweep mode), in the same order, until the Sequencer is stopped.

CDEFined
First, a single sequence is performed. Then, only those channels in continuous sweep mode (`INIT:CONT ON`) are repeated.

*RST: CONTinuous

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

SYSTem:SEQuencer <State>

This command turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error will occur.

A detailed programming example is provided in the R&S FSWP User Manual.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
The Sequencer is activated and a sequential measurement is started immediately.

OFF | 0
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (`INIT:SEQ...`) are not available.

*RST: 0

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single Sequencer mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.
`SYST:SEQ OFF`

5.2.3 Configuring Power Measurements

The following commands work for several power measurements.

CALCulate<n>:MARKer<m>:FUNCtion:POWer:MODE 408
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult? 408
CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect 410
CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe] 410
[SENSe:]POWer:ACHannel:PRESet 411
[SENSe:]POWer:ACHannel:PRESet:RLEVel 411
[SENSe:]POWer:TRACe 412

CALCulate<n>:MARKer<m>:FUNCtion:POWer:MODE <Mode>

This command selects the trace display mode for power measurements.

Parameters:

<Mode>

WRITe
The power is calculated from the current trace.

MAXHold
The power is calculated from the current trace and compared with the previous power value using a maximum algorithm.

Manual operation: See "Power Mode" on page 57

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult? <Measurement>

This command queries the results of power measurements (<n>, <m> are irrelevant).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Suffix:

<sb>

1 | 2 | 3 (4 | 5)
Sub block in a Multi-standard radio measurement;
MSR ACLR: 1 to 5
Multi-SEM: 1 to 3
for all other measurements: irrelevant

Query parameters:

<Measurement>

ACPower | MCACpower
ACLR measurements (also known as adjacent channel power or multicarrier adjacent channel measurements).
Returns the power for every active transmission and adjacent channel. The order is:
• power of the transmission channels
• power of adjacent channel (lower,upper)
• power of alternate channels (lower,upper)
MSR ACLR results:
For MSR ACLR measurements, the order of the returned results is slightly different:
• power of the transmission channels
• total power of the transmission channels for each sub block
• power of adjacent channels (lower, upper)
• power of alternate channels (lower, upper)
• power of gap channels (lower1, upper1, lower2, upper2)
The unit of the return values depends on the scaling of the y-axis:
• logarithmic scaling returns the power in the current unit
• linear scaling returns the power in W

GACLr
For MSR ACLR measurements only: returns a list of ACLR values for each gap channel (lower1, upper1, lower2, upper2)

MACM
For MSR ACLR measurements only: returns a list of CACLR values for each gap channel (lower1, upper1, lower2, upper2)

CN
Carrier-to-noise measurements.
Returns the C/N ratio in dB.

CN0
Carrier-to-noise measurements.
Returns the C/N ratio referenced to a 1 Hz bandwidth in dBm/Hz.

CPOWer
Channel power measurements.
Returns the channel power. The unit of the return values depends on the scaling of the y-axis:
• logarithmic scaling returns the power in the current unit
• linear scaling returns the power in W
For SEM measurements, the return value is the channel power of the reference range (in the specified sub block).

PPOWer
Peak power measurements.
Returns the peak power. The unit of the return values depends on the scaling of the y-axis:
• logarithmic scaling returns the power in the current unit
• linear scaling returns the power in W

For SEM measurements, the return value is the peak power of the reference range (in the specified sub block).

OBANdwidth | OBWidth
Occupied bandwidth.
Returns the occupied bandwidth in Hz.

Usage: Query only

Manual operation: See "Ch Power ACLR" on page 14
See "C/N, C/No" on page 14
See "OBW" on page 14
See "Spectrum Emission Mask" on page 15
See "C/N" on page 89
See "C/N_0" on page 89

CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect <MeasType>

This command selects a power measurement and turns the measurement on.

Parameters:
<MeasType>

ACPower | MCACpower
Adjacent channel leakage ratio (ACLR) aka adjacent channel power or multicarrier adjacent channel.
The R&S FSWP performs the measurement on the trace selected with `[SENSe:]POWer:TRACe`.

CPOWer
Channel power measurement with a single carrier.
The R&S FSWP performs the measurement on the trace selected with `[SENSe:]POWer:TRACe`.

OBANdwidth | OBWidth
Occupied bandwidth measurement.
The R&S FSWP performs the measurement on the trace that marker 1 is positioned on.

CN
Carrier-to-noise ratio measurement.

CN0
Carrier-to-noise ratio measurement referenced to 1 Hz bandwidth

Manual operation: See "Ch Power ACLR" on page 14
See "C/N, C/No" on page 14
See "OBW" on page 14
See "C/N" on page 89
See "C/N_0" on page 89

CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe] <State>

This command turns a power measurement on and off.

The suffixes <n> and <m> are irrelevant.

Parameters:

<State> ON | OFF

ON | 1
The power measurement selected with `CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` is activated.

OFF | 0
A standard frequency sweep is activated.

*RST: OFF

Usage: Setting only

Manual operation: See "C/N" on page 89
See "C/N_0" on page 89

[SENSe:]POWer:ACHannel:PRESet <Measurement>

This command determines the ideal span, bandwidths and detector for the current power measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Parameters:

<Measurement>

ACPower | MCACpower
ACLR measurement

CPOWer
channel power measurement

OBANdwidth | OBWidth
Occupied bandwidth measurement

CN
Carrier to noise ratio

CN0
Carrier to noise ration referenced to a 1 Hz bandwidth

Manual operation: See "Optimized Settings (Adjust Settings)" on page 57
See "Adjust Settings" on page 90
See "Adjust Settings" on page 95

[SENSe:]POWer:ACHannel:PRESet:RLEVel

This command determines the ideal reference level for the current measurement.

This automatic routine makes sure that the that the signal power level does not overload the R&S FSWP or limit the dynamic range by too small a S/N ratio.

To determine the best reference level, the R&S FSWP aborts current measurements and performs a series of test sweeps. After it has finished the test, it continues with the actual measurement.

To get a valid result, you have to perform a complete sweep with synchronization to the sweep end. This is only possible in single sweep mode.

Usage: Event

[SENSe:]POWer:TRACe <TraceNumber>

This command selects the trace channel power measurements are performed on.

For the measurement to work, the corresponding trace has to be active.

Parameters:

<TraceNumber> Range: 1 to 6
*RST: 1

Example: `POW:TRAC 2`
Assigns the measurement to trace 2.

Manual operation: See "Selected Trace" on page 56

5.2.4 Measuring the Channel Power and ACLR

- Managing Measurement Configurations....412
- Configuring Channels....413
- Defining Weighting Filters....418
- Selecting the Reference Channel....420
- Checking Limits....421
- Defining General ACLR Characteristics....427
- Configuring Multi-Standard Radio (MSR) ACLR Measurements....428
- Performing an ACLR Measurement....441
- Analyzing Measurement Results....441
- Programming Examples for Channel Power Measurements....443

5.2.4.1 Managing Measurement Configurations

CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet....412
CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:CATalog?....413
CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:DELete....413
CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:SAVE....413

CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet <Standard>

This command loads a measurement configuration.

The measurement configuration for power measurements consists of weighting filter, channel bandwidth and spacing, resolution and video bandwidth, detector and sweep time.

If the "Multi-Standard Radio" standard is selected (see "Standard" on page 53), different commands are required to configure ACLR measurements (see chapter 5.2.4.7, "Configuring Multi-Standard Radio (MSR) ACLR Measurements", on page 428).

Parameters:

<Standard> For more information see chapter 2.3.9, "Reference: Predefined CP/ACLR Standards", on page 86.
If you want to load a customized configuration, the parameter is a string containing the file name.

Manual operation: See "Predefined Standards" on page 53
See "User-Defined Standards" on page 53

CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:CATalog?

This command queries all files containing ACLR standards.

Return values:

<Standards> List of standard files.

Usage: Query only

Manual operation: See "User-Defined Standards" on page 53

CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:DELete <Standard>

This command deletes a file containing an ACLR standard.

Parameters:

<Standard> String containing the file name of the standard.

Usage: Event

Manual operation: See "User-Defined Standards" on page 53

CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:SAVE <Standard>

This command saves the current ACLR measurement configuration as a new ACLR standard.

The measurement configuration for power measurements consists of weighting filter, channel bandwidth and spacing, resolution and video bandwidth, detector and sweep time.

Parameters:

<Standard> String containing the file name. The file format is xml.

Manual operation: See "User-Defined Standards" on page 53

5.2.4.2 Configuring Channels

[SENSe:]POWer:ACHannel:ACPairs....414
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ACHannel....414
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ALTernate<ch>....414
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>]....415
[SENSe:]POWer:ACHannel:NAME:ACHannel....415
[SENSe:]POWer:ACHannel:NAME:ALTernate<ch>....415

[SENSe:]POWer:ACHannel:NAME:CHANnel<ch>....416
[SENSe:]POWer:ACHannel:SPACing[:ACHannel]....416
[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch>....416
[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch>....417
[SENSe:]POWer:ACHannel:TXCHannel:COUNt....417

[SENSe:]POWer:ACHannel:ACPairs <ChannelPairs>

This command defines the number of pairs of adjacent and alternate channels.

Parameters:

<ChannelPairs> Range: 0 to 12
*RST: 1

Manual operation: See "Number of Channels (Tx, ADJ)" on page 55
See "Number of Adjacent Channels (ADJ Count)" on page 72

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ACHannel <Bandwidth>

This command defines the channel bandwidth of the adjacent channels.

The adjacent channels are the first channels to the left and right of the transmission channels. If you set the channel bandwidth for these channels, the R&S FSWP sets the bandwidth of the alternate channels to the same value (not for MSR signals).

For asymmetrical MSR signals, this command defines the bandwidth of the lower adjacent channel. To configure the bandwidth for the upper adjacent channel, use the `[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:UACHannel` command.

Steep-edged channel filters are available for fast ACLR measurements.

Parameters:

<Bandwidth> Range: 100 Hz to 1000 MHz
*RST: 14 kHz

Manual operation: See "Channel Bandwidths" on page 59
See "Adjacent Channel Bandwidths" on page 73

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ALTernate<ch> <Bandwidth>

This command defines the channel bandwidth of the alternate channels.

For MSR signals, this command defines the bandwidth of the lower alternate channels in asymmetrical configurations. To configure the bandwidth for the upper alternate channel, use the `[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:UALTernate<ch>` command.

If you set the channel bandwidth for the first alternate channel, the R&S FSWP sets the bandwidth of the other alternate channels to the same value, but not the other way round (not for MSR signals). The command works hierarchically: to set a bandwidth of the 3rd and 4th channel, you have to set the bandwidth of the 3rd channel first.

Steep-edged channel filters are available for fast ACLR measurements.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<Bandwidth> Range: 100 Hz to 1000 MHz
*RST: 14 kHz

Manual operation: See "Channel Bandwidths" on page 59
See "Adjacent Channel Bandwidths" on page 73

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>] <Bandwidth>

This command defines the channel bandwidth of the transmission channels.

Steep-edged channel filters are available for fast ACLR measurements.

Suffix:
<ch> 1 to 18
Tx channel number

Parameters:
<Bandwidth> Range: 100 Hz to 1000 MHz
*RST: 14 kHz

Manual operation: See "Channel Bandwidths" on page 59
See "Channel Bandwidth" on page 90
See "Channel Bandwidth" on page 95

[SENSe:]POWer:ACHannel:NAME:ACHannel <Name>

This command defines a name for the adjacent channel.

For MSR ACLR measurements, this command defines the name for the lower adjacent channel in asymmetric channel definitions. To define the name for the upper adjacent channel use the `[SENSe:]POWer:ACHannel:NAME:UACHannel` command.

Parameters:
<Name> String containing the name of the channel
*RST: ADJ

Manual operation: See "Channel Names" on page 61

[SENSe:]POWer:ACHannel:NAME:ALTernate<ch> <Name>

This command defines a name for an alternate channel.

For MSR ACLR measurements, this command defines the name for the lower alternate channel in asymmetric channel definitions. To define the name for the upper alternate channels use the `[SENSe:]POWer:ACHannel:NAME:UALTernate<ch>` command.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:

<Name> String containing the name of the channel
*RST: ALT<1...11>

Manual operation: See "Channel Names" on page 61

[SENSe:]POWer:ACHannel:NAME:CHANnel<ch> <Name>

This command defines a name for a transmission channel.

Suffix:

<ch> 1 to 18
Tx channel number

Parameters:

<Name> String containing the name of the channel
*RST: TX<1...12>

Manual operation: See "Channel Names" on page 61

[SENSe:]POWer:ACHannel:SPACing[:ACHannel] <Spacing>

This command defines the distance from transmission channel to adjacent channel.

For MSR signals, this command defines the distance from the CF of the first Tx channel in the first sub block to the lower adjacent channel. To configure the spacing for the upper adjacent channel in asymmetrical configurations, use the `[SENSe:]POWer:ACHannel:SPACing:UACHannel` command.

A change of the adjacent channel spacing causes a change in the spacing of all alternate channels below the adjacent channel (not for MSR signals).

Parameters:

<Spacing> Range: 100 Hz to 2000 MHz
*RST: 14 kHz

Usage: SCPI confirmed

Manual operation: See "Channel Spacings" on page 59
See "Adjacent Channel Spacings" on page 72

[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch> <Spacing>

This command defines the distance from transmission channel to alternate channels.

For MSR signals, this command defines the distance from the CF of the first Tx channel in the first sub block to the lower alternate channel. To configure the spacing for the upper alternate channel in asymmetrical configurations, use the `[SENSe:]POWer:ACHannel:SPACing:UALTernate<ch>` command.

If you set the channel spacing for the first alternate channel, the R&S FSWP adjusts the spacing of alternate channels of a lower order, but not the other way round (not for MSR signals). The command works hierarchically: to set a distance from the transmission channel to the 2nd and 3rd alternate channel, you have to define a spacing for the 2nd alternate channel first.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<Spacing> Range: 100 Hz to 2000 MHz
*RST: 40 kHz (ALT1), 60 kHz (ALT2), 80 kHz (ALT3), ...

Manual operation: See "Channel Spacings" on page 59
See "Adjacent Channel Spacings" on page 72

[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch> <Spacing>

This command defines the distance between transmission channels.

If you set the channel spacing for a transmission channel, the R&S FSWP sets the spacing of the lower transmission channels to the same value, but not the other way round. The command works hierarchically: to set a distance between the 2nd and 3rd and 3rd and 4th channel, you have to set the spacing between the 2nd and 3rd channel first.

Suffix:
<ch> 1 to 18
Tx channel number

Parameters:
<Spacing> Range: 14 kHz to 2000 MHz
*RST: 20 kHz

Manual operation: See "Channel Spacings" on page 59

[SENSe:]POWer:ACHannel:TXCHannel:COUNt <Number>

This command defines the number of transmission channels.

The command works for measurements in the frequency domain.

Parameters:
<Number> Range: 1 to 18
*RST: 1

Manual operation: See "Number of Channels (Tx, ADJ)" on page 55

5.2.4.3 Defining Weighting Filters

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel 418
[SENSe:]POWer:ACHannel:FILTer:ALPHa[:ALL] 418
[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch> 418
[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch> 419
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel 419
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALL 419
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch> 419
[SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch> 420

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel <Alpha>

This command defines the roll-off factor for the adjacent channel weighting filter.

For asymmetrical MSR signals, this command defines the roll-off factor for the lower adjacent channel. To configure the factor for the upper adjacent channel, use the `[SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel` command.

Parameters:

<Alpha> Roll-off factor

Range: 0 to 1
*RST: 0.22

Manual operation: See "Weighting Filters" on page 61
See "Weighting Filters" on page 73

[SENSe:]POWer:ACHannel:FILTer:ALPHa[:ALL] <Value>

This command defines the alpha value for the weighting filter for all channels.

Parameters:

<Value> <numeric value>

*RST: 0.22

Example:

```
POW:ACH:FILT:ALPH:ALL 0.35
```

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch> <Alpha>

This command defines the roll-off factor for the alternate channel weighting filter.

For asymmetrical MSR signals, this command defines the roll-off factor for the lower alternate channels. To configure the factor for the upper alterante channels, use the `[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch>` command.

Suffix:

<ch> 1 to 11
Alternate channel number

Parameters:
<Alpha> Roll-off factor
Range: 0 to 1
*RST: 0.22

Manual operation: See "Weighting Filters" on page 61
See "Weighting Filters" on page 73

[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch> <Alpha>

This command defines the roll-off factor for the transmission channel weighting filter.

Suffix:
<ch> 1 to 18
Tx channel number

Parameters:
<Alpha> Roll-off factor
Range: 0 to 1
*RST: 0.22

Manual operation: See "Weighting Filters" on page 61

[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel <State>

This command turns the weighting filter for the adjacent channel on and off.

For asymmetrical MSR signals, this command turns the weighting filter for the lower adjacent channel on and off. To configure the filter state for the upper adjacent channel, use the `[SENSe:]POWer:ACHannel:FILTer[:STATe]:UACHannel` command.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Weighting Filters" on page 61
See "Weighting Filters" on page 73

[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALL <State>

This command turns the weighting filters for all channels on and off.

Parameters:
<State> ON | OFF
*RST: OFF

[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch> <State>

This command turns the weighting filter for an alternate channel on and off.

For asymmetrical MSR signals, this command turns the weighting filter for the lower alternate channels on and off. To configure the filter state for the upper alternate channels, use the `[SENSe:]POWer:ACHannel:FILTer[:STATe]:UALTernate<ch>` command.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Weighting Filters" on page 61
See "Weighting Filters" on page 73

[SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch> <State>

This command turns the weighting filter for a transmission channel on and off.

Suffix:
<ch> 1 to 18
Tx channel number

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Weighting Filters" on page 61

5.2.4.4 Selecting the Reference Channel

[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE 420
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO 420
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual 421

[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE

This command sets the channel power as the reference for relative ACLR measurements.

Example: `POW:ACH:REF:AUTO ONCE`

Usage: Event

Manual operation: See "Setting a Fixed Reference for Channel Power Measurements (Set CP Reference)" on page 57

[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO <RefChannel>

This command selects the reference channel for relative measurements.

You need at least one channel for the command to work.

Parameters:

<RefChannel>

MINimum
Transmission channel with the lowest power

MAXimum
Transmission channel with the highest power

LHIGhest
Lowest transmission channel for lower adjacent channels and highest transmission channel for upper adjacent channels

Example: `POW:ACH:REF:TXCH:AUTO MAX`
Selects the channel with the peak power as reference channel.

Manual operation: See "Reference Channel" on page 55

[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual <ChannelNumber>

This command defines a reference channel for relative ACLR measurements.

You need at least one channel for the command to work.

Note that this command is not available for MSR ACLR measurements (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412).

Parameters:

<ChannelNumber>

Range: 1 to 18
*RST: 1

Manual operation: See "Reference Channel" on page 55

5.2.4.5 Checking Limits

The results of the limit checks are also indicated in the `STATus:QUEStionable:ACLR` status register.

For more information see the R&S FSWP User Manual.

CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute 422
CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute:STATe 422
CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative] 422
CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]:STATe 423
CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? 423
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute 424
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute:STATe 424
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative] 425
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative]:STATe 425
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:RESult? 426
CALCulate<n>:LIMit<k>:ACPower[:STATe] 426

CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute <LowerLimit>, <UpperLimit>

This command defines the absolute limit of the adjacent channels.

(<n>, <k> are irrelevant.)

If you have defined an absolute limit as well as a relative limit, the R&S FSWP uses the lower value for the limit check.

Parameters:

<LowerLimit> The limit of the lower adjacent channel.

Range: -200 dBm to 200 dBm
*RST: -200 dBm

<UpperLimit> The limit of the upper adjacent channel.

Range: -200 dBm to 200 dBm
*RST: -200 dBm

Manual operation: See "Limit Checking" on page 60
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute:STATe

This command turns the absolute limit check for the adjacent channels on and off.

(<n>, <k> are irrelevant.)

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Parameters:

<State> ON | OFF

Absolute limit check for lower adjacent channel

*RST: OFF

<State> ON | OFF

Absolute limit check for upper adjacent channel

*RST: OFF

Manual operation: See "Limit Checking" on page 60
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative] <LowerLimit>, <UpperLimit>

This command defines the relative limit of the adjacent channels. The reference value for the relative limit is the measured channel power.

(<n>, <k> are irrelevant.)

If you have defined an absolute limit as well as a relative limit, the R&S FSWP uses the lower value for the limit check.

Parameters:

<LowerLimit> The limit of the lower adjacent channel.

Range: 0 dB to 100 dB
*RST: 0 dB
Default unit: dB

<UpperLimit> The limit of the upper adjacent channel.

Range: 0 dB to 100 dB
*RST: 0 dB
Default unit: dB

Manual operation: See "Limit Checking" on page 60
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]:STATe

This command turns the relative limit check for the adjacent channels on and off.

(<n>, <k> are irrelevant.)

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Parameters:

<State> ON | OFF

Relative limit check for lower adjacent channel

*RST: OFF

<State> ON | OFF

Relative limit check for upper adjacent channel

*RST: OFF

Manual operation: See "Limit Checking" on page 60
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?

This command queries the state of the limit check for the adjacent channels in an ACLR measurement.

(<n>, <k> are irrelevant.)

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:

<LowerACH>, <UpperACH>
text value
The command returns two results. The first is the result for the lower, the second for the upper adjacent channel.

PASSED
Limit check has passed.

FAIL
Limit check has failed.

Example:
```
INIT:IMM;*WAI;
CALC:LIM:ACP:ACH:RES?
PASSED,PASSED
```

Usage: Query only

Manual operation: See "Limit Checking" on page 60
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute <LowerLimit>, <UpperLimit>

This command defines the absolute limit of the alternate channels.

(<n>, <k> are irrelevant.)

If you have defined an absolute limit as well as a relative limit, the R&S FSWP uses the lower value for the limit check.

Suffix:

<ch>
1 to 11
Alternate channel number

Parameters:

<LowerLimit>
The limit of the lower adjacent channel.

Range: -200 dBm to 200 dBm
*RST: -200 dBm

<UpperLimit>
The limit of the upper adjacent channel.

Range: -200 dBm to 200 dBm
*RST: -200 dBm

Manual operation: See "Limit Checking" on page 60
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute:STATe

This command turns the absolute limit check for the alternate channels on and off.

(<n>, <k> are irrelevant.)

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<State> ON | OFF
Absolute limit check for lower alternate channel
*RST: OFF

<State> ON | OFF
Absolute limit check for upper alternate channel
*RST: OFF

Manual operation: See "Limit Checking" on page 60
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative] <LowerLimit>, <UpperLimit>

This command defines the relative limit of the alternate channels. The reference value for the relative limit is the measured channel power.

(<n>, <k> are irrelevant.)

If you have defined an absolute limit as well as a relative limit, the R&S FSWP uses the lower value for the limit check.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<LowerLimit> The limit of the lower alternate channel.
Range: 0 dB to 100 dB
*RST: 0 dB
Default unit: dB

<UpperLimit> The limit of the upper alternate channel.
Range: 0 dB to 100 dB
*RST: 0 dB
Default unit: dB

Manual operation: See "Limit Checking" on page 60
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative]:STATe

This command turns the relative limit check for the alternate channels on and off.

(<n>, <k> are irrelevant.)

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<State> ON | OFF
Relative limit check for lower alternate channel
*RST: OFF

<State> ON | OFF
Relative limit check for upper alternate channel
*RST: OFF

Manual operation: See "Limit Checking" on page 60
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:RESult?

This command queries the state of the limit check for the adjacent or alternate channels in an ACLR measurement.

(<n>, <k> are irrelevant.)

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Suffix:
<ch> 1 to 11
Alternate channel number

Return values:
<LowerChan>, <UpperChan> text value
The command returns two results. The first is the result for the lower, the second for the upper adjacent or alternate channel.
PASSED
Limit check has passed.
FAIL
Limit check has failed.

Example:
```
INIT:IMM;*WAI;
CALC:LIM:ACP:ACH:RES?
PASSED,PASSED
```

Usage: Query only

CALCulate<n>:LIMit<k>:ACPower[:STATe] <State>

This command turns the limit check for ACLR measurements on and off.

In addition, limits must be defined and activated individually for each channel (see CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]:STATe, CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative]:STATe, CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute:STATe, CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR[:RELative:]STATe and CALCulate<n>:LIMit<k>:ACPower:GAP<gap>[:CACLr][:RELative:]STATe).

(<n>, <k> are irrelevant.)

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "Limit Checking" on page 60
See "Limit Checking" on page 68
See "Limit Checking" on page 73
See "Limit Checking" on page 76

5.2.4.6 Defining General ACLR Characteristics

Useful commands to define general ACLR characteristics described elsewhere:

- CALCulate<n>:MARKer<m>:FUNCtion:POWer:MODE on page 408
- [SENSe:]POWer:NCORrection on page 575
- [SENSe:]POWer:ACHannel:PRESet on page 411
- [SENSe:]POWer:ACHannel:PRESet:RLEVel on page 411
- [SENSe:]POWer:TRACe on page 412

[SENSe:]POWer:HSPeed 427

[SENSe:]POWer:HSPeed <State>

This command turns high speed ACLR and channel power measurements on and off.

If on, the R&S FSWP performs a measurement on each channel in the time domain. It returns to the frequency domain when the measurement is done.

In some telecommunications standards, high speed measurements use weighting filters with characteristic or steep-edged channel filters for band limitation.

Parameters:

<State> ON | OFF

*RST: OFF

Example: POW:HSP ON

Manual operation: See "Fast ACLR" on page 56

5.2.4.7 Configuring Multi-Standard Radio (MSR) ACLR Measurements

When you are performing multi-standard radio ACLR measurements, you have to configure channels differently. In that case, use the remote commands described here instead.

Useful commands to perform MSR ACLR measurements described elsewhere:

- `CALCulate<n>:LIMit<k>:ACPower[:STATe]` on page 426
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer:MODE` on page 408
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult:PHZ` on page 442
- `[SENSe:]POWer:ACHannel:MODE` on page 443
- `[SENSe:]POWer:ACHannel:PRESet` on page 411
- `[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO` on page 420
- `[SENSe:]POWer:NCORrection` on page 575
- `[SENSe:]POWer:TRACe` on page 412

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute....429
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute:STATe....429
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR[:RELative]....429
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR[:RELative:]STATe....430
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>[:CACLr][:RELative]....430
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>[:CACLr][:RELative:]STATe....431
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RESult?....431
[SENSe:]POWer:ACHannel:AGCHannels....432
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:GAP<gap>....432
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:UACHannel....432
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:UALTernate<ch>....433
[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>....433
[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLock<sb>:CHANnel<ch>....433
[SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel....434
[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch>....434
[SENSe:]POWer:ACHannel:FILTer:STATe:GAP<gap>....434
[SENSe:]POWer:ACHannel:FILTer:STATe:SBLock<sb>:CHANnel<ch>....435
[SENSe:]POWer:ACHannel:FILTer[:STATe]:UACHannel....435
[SENSe:]POWer:ACHannel:FILTer[:STATe]:UALTernate<ch>....435
[SENSe:]POWer:ACHannel:GAP<gap>:MSIZe....435
[SENSe:]POWer:ACHannel:NAME:GAP<gap>....436
[SENSe:]POWer:ACHannel:NAME:UACHannel....436
[SENSe:]POWer:ACHannel:NAME:UALTernate<ch>....436
[SENSe:]POWer:ACHannel:SBCount....437
[SENSe:]POWer:ACHannel:SBLock<sb>:BANDwidth|BWIDth[:CHANnel<ch>]....437
[SENSe:]POWer:ACHannel:SBLock<sb>:CENTer[:CHANnel<ch>]....437
[SENSe:]POWer:ACHannel:SBLock<sb>:FREQuency:CENTer....438
[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>]....438
[SENSe:]POWer:ACHannel:SBLock<sb>:RFBWidth....438
[SENSe:]POWer:ACHannel:SBLock<sb>:TECHnology[:CHANnel<ch>]....439
[SENSe:]POWer:ACHannel:SBLock<sb>:TXCHannel:COUNt....439

[SENSe:]POWer:ACHannel:SPACing:GAP<gap>....440
[SENSe:]POWer:ACHannel:SPACing:UACHannel....440
[SENSe:]POWer:ACHannel:SPACing:UALTernate<ch>....440
[SENSe:]POWer:ACHannel:SSETup....441

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute <Limit>, <Reserved>

This command defines the absolute limit of the specified gap (CACLR) channel.

(<n>, <k> are irrelevant.)

If you have defined an absolute limit as well as a relative limit, the R&S FSWP uses the lower value for the limit check.

Suffix:
<gap> 1 | 2
Gap (CACLR) channel number

Parameters:
<Limit> Defines the absolute limit of the specified gap channel in dBm.

<Reserved> Ignored.

Example: `CALC:LIM:ACP:GAP2:ABS 44.2dBm,0`

Manual operation: See "Limit Checking" on page 76

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute:STATe <State>

This command turns the absolute limit check for the specified gap (CACLR) channel on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Suffix:
<gap> 1 | 2
Gap (CACLR) channel number

<n>, <k> irrelevant

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Limit Checking" on page 76

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR[:RELative] <Limit>

This command defines the relative limit for the ACLR power in the specified gap channel. The reference value for the relative limit is the measured channel power.

(<n>, <k> are irrelevant.)

If you have defined an absolute limit as well as a relative limit, the R&S FSWP uses the lower value for the limit check.

Suffix:
<gap> 1 | 2
Gap channel number

Parameters:
<Limit> Defines the relative limit for the ACLR power in the specified gap channel in dB.

Example: `CALC:LIM:ACP:GAP1:ACLR:REL 3dB`

Manual operation: See "Limit Checking" on page 76

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR[:RELative:]STATe <State>

This command turns the relative limit check for the ACLR power in the specified gap channel on and off.

(<n>, <k> are irrelevant.)

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Suffix:
<gap> 1 | 2
Gap channel number

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:LIM:ACP:GAP1:ACLR:REL:STAT ON`

Manual operation: See "Limit Checking" on page 76

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>[:CACLr][:RELative] <Limit>

This command defines the relative limit for the CACLR power in the specified gap channel. The reference value for the relative limit is the measured channel power.

(<n>, <k> are irrelevant.)

If you have defined an absolute limit as well as a relative limit, the R&S FSWP uses the lower value for the limit check.

Suffix:
<gap> 1 | 2
Gap channel number

Parameters:
<Limit> Defines the relative limit of the specified gap channel in dB.

Example: `CALC:LIM:ACP:GAP1:REL 3dB`

Manual operation: See "Limit Checking" on page 76

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>[:CACLr][:RELative:]STATe <State>

This command turns the relative limit check for the CACLR power in the specified gap channel on and off.

(<n>, <k> are irrelevant.)

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Suffix:
<gap> 1 | 2
Gap channel number

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:LIM:ACP:GAP1:REL:STAT ON`

Manual operation: See "Limit Checking" on page 76

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RESult?

This command queries the state of the limit check for *all* gap (CACLR) channels in an MSR ACLR measurement.

(<n>, <k> are irrelevant.)

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

The results of the power limit checks are also indicated in the `STAT:QUES:ACPL` status registry.

Suffix:
<gap> 1 | 2
irrelevant

Return values:
<LowerGap1>, <UpperGap1>, <LowerGap2>, <UpperGap2> The command returns the results for the four gap channels for each gap (max. 4).

PASSED
Limit check has passed.

FAIL
Limit check has failed.

NONE
No results available, e.g. because limit checking was deactivated

Example:
```
INIT:IMM;*WAI;
CALC:LIM:ACP:GAP2:RES?
PASSED,PASSED,
```

Usage: Query only

Manual operation: See "Limit Checking" on page 76

[SENSe:]POWer:ACHannel:AGCHannels <State>

This command activates or deactivates gap channels in an MSR signal.

For more information see chapter 2.3.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 47.

Parameters:

<State> ON | OFF | 1 | 0

ON | 1
The gap channels are displayed and channel power results are calculated and displayed in the Result Summary.

OFF | 0
The gap channels are not displayed in the diagram and channel power results are not calculated nor displayed in the Result Summary.

*RST: ON

Manual operation: See "Activate Gaps" on page 75

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:GAP<gap> <Bandwidth>

This command defines the bandwidth of the specified MSR gap (CACLR) channel.

This command is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412).

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<Bandwidth> numeric value in Hz

*RST: 3.84 MHz

Manual operation: See "Gap Channel Bandwidths" on page 76

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:UACHannel <Bandwidth>

This command defines the channel bandwidth of the upper adjacent channel in asymmetrical configurations.

The adjacent channel is the first pair of channels next to the transmission channels. To configure the bandwidth for the lower adjacent channel, use the `[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ACHannel` command.

Steep-edged channel filters are available for fast ACLR measurements.

Parameters:

<Bandwidth> Range: 100 Hz to 1000 MHz
*RST: 14 kHz

Manual operation: See "Adjacent Channel Bandwidths" on page 73

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:UALTernate<ch> <Bandwidth>

This command defines the channel bandwidth of the upper alternate channels in asymmetrical configurations. To configure the bandwidth for the lower alternate channel, use the `[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ALTernate<ch>` command.

Steep-edged channel filters are available for fast ACLR measurements.

Suffix:

<ch> 1 to 11
Alternate channel number

Parameters:

<Bandwidth> Range: 100 Hz to 1000 MHz
*RST: 14 kHz

Manual operation: See "Adjacent Channel Bandwidths" on page 73

[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap> <Alpha>

This command defines the roll-off factor for the specified gap (CACLR) channel's weighting filter.

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<Alpha> Roll-off factor

Range: 0 to 1
*RST: 0.22

Manual operation: See "Weighting Filters" on page 76

[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLock<sb>:CHANnel<ch> <Alpha>

This command defines the roll-off factor for the specified transmission channel's weighting filter.

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

<ch> 1 to 18
Tx channel number

Parameters:

<Alpha> Roll-off factor

Range: 0 to 1
*RST: 0.22

Manual operation: See "Weighting Filters" on page 71

[SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel <Alpha>

This command defines the roll-off factor for the upper adjacent channel weighting filter for asymmetrical MSR signals. To configure the factor for the upper adjacent channel, use the `[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel` command.

Parameters:

<Alpha> Roll-off factor

Range: 0 to 1
*RST: 0.22

Manual operation: See "Weighting Filters" on page 73

[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch> <Alpha>

This command defines the roll-off factor for the upper alternate channels' weighting filter for asymmetrical MSR signals. To configure the factor for the upper alternate channels, use the `[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch>` command.

Suffix:

<ch> 1 to 11
Alternate channel number

Parameters:

<Alpha> Roll-off factor

Range: 0 to 1
*RST: 0.22

Manual operation: See "Weighting Filters" on page 73

[SENSe:]POWer:ACHannel:FILTer:STATe:GAP<gap> <State>

This command turns the weighting filter for the specified gap (CACLR) channel on and off.

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "Weighting Filters" on page 76

[SENSe:]POWer:ACHannel:FILTer:STATe:SBLock<sb>:CHANnel<ch> <State>

This command turns the weighting filter for the specified transmission channel on and off.

Suffix:
<sb> 1 | 2 | 3 | 4 | 5
sub block number

<ch> 1 to 18
Tx channel number

Parameters:
<State> ON | OFF
*RST: W-CDMA: ON, other technologies: OFF

Manual operation: See "Weighting Filters" on page 71

[SENSe:]POWer:ACHannel:FILTer[:STATe]:UACHannel <State>

This command turns the weighting filter for the upper adjacent channel on and off for asymmetrical MSR signals. To configure the factor for the lower adjacent channel, use the `[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel` command.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Weighting Filters" on page 73

[SENSe:]POWer:ACHannel:FILTer[:STATe]:UALTernate<ch> <State>

This command turns the weighting filter for the upper alternate channels on and off for asymmetrical MSR signals. To configure the factor for the lower alternate channels, use the `[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch>` command.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Weighting Filters" on page 73

[SENSe:]POWer:ACHannel:GAP<gap>:MSIZe <Bandwidth>

If the gap between the sub blocks does not exceed the specified bandwidth, the gap channels are not displayed in the diagram, and the gap channel results are not calculated in the result summary.

Suffix:
<gap> 1 | 2
Gap channel number

Parameters:
<Bandwidth> numeric value in Hz
*RST: gap1: 5 MHz; gap2: 10 MHz

Example: `POW:ACH:GAP2:MSIZ 5MHZ`

Usage: SCPI confirmed

Manual operation: See "Minimum gap size to show gap 1/2" on page 75

[SENSe:]POWer:ACHannel:NAME:GAP<gap> <Name>

This command defines a name for the GAP channel.

Suffix:
<gap> 1 | 2
Gap channel number

Parameters:
<Name> String containing the name of the channel
*RST: Gap1, Gap2

[SENSe:]POWer:ACHannel:NAME:UACHannel <Name>

This command defines the name for the upper adjacent channel in asymmetrical MSR channel definitions. To define the name for the lower adjacent channel use the `[SENSe:]POWer:ACHannel:NAME:ACHannel` command.

Parameters:
<Name> String containing the name of the channel
*RST: ADJ

[SENSe:]POWer:ACHannel:NAME:UALTernate<ch> <Name>

This command defines the name for the specified upper alternate channel in asymmetrical MSR channel definitions. To define the name for the lower adjacent channels use the `[SENSe:]POWer:ACHannel:NAME:ALTernate<ch>` command.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<Name> String containing the name of the channel
*RST: ALT<1...11>

[SENSe:]POWer:ACHannel:SBCount <Number>

This command defines the number of sub blocks, i.e. groups of transmission channels in an MSR signal.

For more information see chapter 2.3.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 47.

Parameters:

<Number> Range: 1 to 5
*RST: 1

Manual operation: See "Number of Sub Blocks" on page 65

[SENSe:]POWer:ACHannel:SBLock<sb>:BANDwidth|BWIDth[:CHANnel<ch>] <Bandwidth>

This command defines the bandwidth of the specified MSR Tx channel.

This command is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412).

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

<ch> 1 to 18
Tx channel number

Parameters:

<Bandwidth> Bandwidth in Hz

Manual operation: See "Tx Channel Bandwidth" on page 70

[SENSe:]POWer:ACHannel:SBLock<sb>:CENTer[:CHANnel<ch>] <Frequency>

This command defines the (absolute) center frequency of the specified MSR Tx channel.

Note that the position of the first Tx channel in the first sub block and the last Tx channel in the last sub block also affect the position of the adjacent channels.

This command is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412).

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

<ch> 1 to 18
Tx channel number

Parameters:

<Frequency> absolute frequency in Hz

Manual operation: See "Tx Center Frequency" on page 70

[SENSe:]POWer:ACHannel:SBLock<sb>:FREQuency:CENTer <Frequency>

This command defines the center of the specified MSR sub block. Note that the position of the sub block also affects the position of the adjacent gap (CACLR) channels.

This command is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412).

Suffix:
<sb> 1 | 2 | 3 | 4 | 5
sub block number

Parameters:
<Frequency> absolute frequency in Hz

Manual operation: See "Sub Block Center Frequency" on page 69

[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>] <Name>

This command defines the name of the specified MSR Tx channel.

This command is for MSR signals only.

Suffix:
<sb> 1 | 2 | 3 | 4 | 5
sub block number

<ch> 1 to 18
Tx channel number

Parameters:
<Name> String containing the name of the channel

Example: `POW:ACH:SBL2:NAME:CHAN2 'B:WCDMA'`

Manual operation: See "Tx Channel Definition" on page 69

[SENSe:]POWer:ACHannel:SBLock<sb>:RFBWidth <Bandwidth>

This command defines the bandwidth of the individual MSR sub block. Note that sub block ranges also affect the position of the adjacent gap channels (CACLR).

This command is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412).

Suffix:
<sb> 1 | 2 | 3 | 4 | 5
sub block number

Parameters:
<Bandwidth> Bandwidth in Hz

Manual operation: See "RF Bandwidth" on page 69

[SENSe:]POWer:ACHannel:SBLock<sb>:TECHnology[:CHANnel<ch>]
<Standard>

This command defines the technology used for transmission by the specified MSR Tx channel.

This command is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412).

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

<ch> 1 to 18
Tx channel number

Parameters:

<Standard> GSM | WCDMa | LTE_1_40 | LTE_3_00 | LTE_5_00 | LTE_10_00 | LTE_15_00 | LTE_20_00 | USER

Technology used for transmission

GSM
Transmission according to GSM standard

WCDMa
Transmission according to W-CDMA standard

LTE_1_40 | LTE_3_00 | LTE_5_00 | LTE_10_00 | LTE_15_00 | LTE_20_00
Transmission according to LTE standard for different channel bandwidths

USER
User-defined transmission; no automatic preconfiguration possible

Manual operation: See "Technology Used for Transmission" on page 70

[SENSe:]POWer:ACHannel:SBLock<sb>:TXCHannel:COUNt <Number>

This command defines the number of transmission channels the specific sub block contains.

This command is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 412).

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

Parameters:

<Number> Range: 1 to 18
*RST: 1

Manual operation: See "Number of Tx Channels (Tx Count)" on page 69

[SENSe:]POWer:ACHannel:SPACing:GAP<gap> <Spacing>

This command defines the distance from sub block to the specified gap channel.

The channels in the upper gap are identical to those in the lower gap. Thus, in the R&S FSWP MSR ACLR measurement, only 2 gap channels are configured.

The spacing for gap channels is defined in relation to the outer edges of the surrounding sub blocks, i.e.

Spacing = [CF of the gap channel] - [left sub block center] + ([RF bandwidth of left sub block] /2)

(See also figure 2-24 and figure 2-25.)

Suffix:
<gap> 1 | 2
Gap channel number

Parameters:
<Spacing> numeric value in Hz
*RST: 2.5 MHz

Usage: SCPI confirmed

Manual operation: See "Gap Channel Spacings" on page 75

[SENSe:]POWer:ACHannel:SPACing:UACHannel <Spacing>

This command defines the distance from the transmission channel to the upper adjacent channel.

For MSR signals, this command defines the distance from the CF of the last Tx channel in the last sub block to the upper adjacent channel in asymmetrical configurations. To configure the spacing for the lower adjacent channel use the `[SENSe:]POWer:ACHannel:SPACing[:ACHannel]` command.

Parameters:
<Spacing> Range: 100 Hz to 2000 MHz
*RST: 14 kHz

Usage: SCPI confirmed

Manual operation: See "Adjacent Channel Spacings" on page 72

[SENSe:]POWer:ACHannel:SPACing:UALTernate<ch> <Spacing>

This command defines the distance from transmission channel to the upper alternate channels.

For MSR signals, this command defines the distance from the CF of the last Tx channel in the last sub block to the upper alternate channel in asymmetrical configurations. To configure the spacing for the lower alternate channel, use the `[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch>` command.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<Spacing> Range: 100 Hz to 2000 MHz
*RST: 40 kHz (ALT1), 60 kHz (ALT2), 80 kHz (ALT3), ...

Manual operation: See "Adjacent Channel Spacings" on page 72

[SENSe:]POWer:ACHannel:SSETup <State>

This command defines whether adjacent channels are defined symmetrically or not.

For more information see chapter 2.3.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 47.

Parameters:
<State> ON | OFF | 1 | 0

ON | 1
The upper and lower adjacent and alternate channels are defined symmetrically. This is the default behaviour and corresponds to the behavior in firmware versions before 2.10.

OFF | 0
The upper and lower channels can be configured differently.

*RST: ON

Manual operation: See "Symmetrical Adjacent Setup" on page 68

5.2.4.8 Performing an ACLR Measurement

Useful commands to perform ACLR measurements described elsewhere:

- `CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` on page 410
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe]` on page 410
- `INITiate<n>[:IMMediate]` on page 403

5.2.4.9 Analyzing Measurement Results

Useful commands to analyze ACLR measurements described elsewhere:

- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?` on page 408
- `TRACe<n>[:DATA]` on page 606

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RESult? 442
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult:PHZ 442
[SENSe:]POWer:ACHannel:MODE 443

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RESult?

This command queries the state of the limit check for *all* gap (CACLR) channels in an MSR ACLR measurement.

(<n>, <k> are irrelevant.)

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

The results of the power limit checks are also indicated in the `STAT:QUES:ACPL` status registry.

Suffix:

<gap> 1 | 2
irrelevant

Return values:

<LowerGap1>, <UpperGap1>, <LowerGap2>, <UpperGap2> The command returns the results for the four gap channels for each gap (max. 4).

PASSED
Limit check has passed.

FAIL
Limit check has failed.

NONE
No results available, e.g. because limit checking was deactivated

Example:

```
INIT:IMM;*WAI;
CALC:LIM:ACP:GAP2:RES?
PASSED,PASSED,
```

Usage: Query only

Manual operation: See "Limit Checking" on page 76

CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult:PHZ <State>

This command selects the way the R&S FSWP returns results for power measurements.

You can query results with `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?`.

Parameters:

<State> ON | OFF

ON
Channel power density in dBm/Hz

OFF
Channel power in dBm

*RST: OFF

Example: `CALC:MARK:FUNC:POW:RES:PHZ ON`
Output of results referred to the channel bandwidth.

Manual operation: See "Channel Power Levels and Density (Power Unit)" on page 56

[SENSe:]POWer:ACHannel:MODE <Mode>

This command selects the way the R&S FSWP displays the power of adjacent channels.

You need at least one adjacent channel for the command to work.

Parameters:

<Mode>

ABSolute
Shows the absolute power of all channels

RELative
Shows the power of adjacent and alternate channels in relation to the transmission channel

*RST: RELative

Manual operation: See "Absolute and Relative Values (ACLR Mode)" on page 56

5.2.4.10 Programming Examples for Channel Power Measurements

The following programming examples are meant to demonstrate the most important commands to perform channel power measurements in a remote environment.

- Example: Configuring and Performing an ACLR Measurement.....443
- Example: Configuring and Performing an MSR ACLR Measurement.....445

Example: Configuring and Performing an ACLR Measurement

In this example we will configure and perform an adjacent-channel power measurement. Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task. For most common measurement standards, the R&S FSWP performs the measurement optimally with the predefined settings, without further configuration.

```
//-------------Preparing the measurement---------------------
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.

CALC:MARK:FUNC:POW:SEL ACP
//Activates adjacent-channel power measurement.
CALC:MARK:FUNC:POW:PRES GSM
//Selects the user standard "GSM"

//---------------Setting Up Channels------------
POW:ACH:TXCH:COUN 1
```

```
//Creates one transmission channel.
POW:ACH:NAME:CHAN1 'TX Channel'
//Names the first transmission channel 'TX Channel'.
POW:ACH:ACP 2
//Creates two adjacent channels - one adjacent channel and one alternate channel.
POW:ACH:NAME:ACH 'ABC'
//Names the adjacent channel 'ABC'
POW:ACH:NAME:ALT1 'XYZ'
//Names the first alternate channel 'XYZ'.
POW:ACH:BWID:CHAN1 30kHz
//Defines a bandwidth of 30 kHz for the transmission channel.
POW:ACH:BWID:ACH 30kHz
//Defines a bandwidth of 30 kHz for the adjacent channel.
POW:ACH:BWID:ALT1 30kHz
//Defines a bandwidth of 30 kHz for the first alternate channel.
POW:ACH:SPAC 33kHz
//Defines a distance of 33 kHz from the center of the transmission channel to the
//center of the adjacent channel.
//Also adjusts the distance to the alternate channels (66 kHz).
POW:ACH:SPAC:ALT1 100kHz
//Defines a distance of 100 kHz from the center of the transmission channel to the
//center of the first alternate channel.

//---------------Selecting a Reference Channel--
POW:ACH:MODE REL
//Selects relative display of the channel power.
POW:ACH:REF:TXCH:MAN 1
//Defines transmission channel 1 as the reference channel.

//-----------Saving the settings as a user standard--------------
CALC:MARK:FUNC:POW:STAN:SAVE 'my_aclr_standard'
//Saves the user standard with the name "my_aclr_standard".
//Weighting filters can only be defined for user-defined standards.

//---------------Defining Weighting Filters-----
POW:ACH:FILT:ALPH:CHAN1 0.35
//Defines a roll-off factor of 0.35 for the weighting filter of the first
//transmission channel.
POW:ACH:FILT:CHAN1 ON
//Turns the weighting filter for the first transmission channel on.
POW:ACH:FILT:ALPH:ACH 0.35
//Defines a roll-off factor of 0.35 for the weighting filter of the adjacent
//channel.
POW:ACH:FILT:ACH ON
//Turns the weighting filter for the adjacent channel on.
POW:ACH:FILT:ALPH:ALT1 0.35
//Defines a roll-off factor of 0.35 for the weighting filter of the first
//alternate channel.
POW:ACH:FILT:ALT1 ON
//Turns the weighting filter for the first alternate channel on.
```

```
//---------------Working with Limits------------
CALC:LIM:ACP:ACH 30DB,30DB
//Defines a relative limit of 30 dB below the power of the reference channel
//for both adjacent channels.
CALC:LIM:ACP:ALT1 25DB,25DB
//Defines a relative limit of 25 dB below the power of the reference channel
//for the first alternate channels.
CALC:LIM:ACP:ACH:ABS -35DBM,-35DBM
//Defines an absolute limit of -35 dBm for both adjacent channels.
CALC:LIM:ACP ON
//Turns the ACLR limit check on.
CALC:LIM:ACP:ACH:STAT ON
//Turns the relative limit check for adjacent channels on.
CALC:LIM:ACP:ACH:ABS:STAT ON
//Turns the absolute limit check for adjacent channels on.
CALC:LIM:ACP:ALT1:ABS:STAT ON
//Turns the absolute limit check for the first alternate channel on.

//--------------Performing the Measurement-----
POW:ACH:PRES ACP;*WAI
//Determines the ideal ACLR measurement configuration.
POW:ACH:PRES:RLEV;*WAI
//Determines the ideal reference level for the measurement.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Limit Check--------------------
CALC:LIM:ACP:ACH:RES?
//Queries the results of the limit check for the adjacent channels.
CALC:LIM:ACP:ALT1:RES?
//Queries the results of the limit check for the first alternate channels.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:POW:RES? ACP
//Returns the results for the ACLR measurement.
```

Example: Configuring and Performing an MSR ACLR Measurement

This example demonstrates how to configure and perform an ACLR measurement on a multi-standard radio signal in a remote environment.

```
//--------------Preparing the instrument -----------
//Reset the instrument
*RST

// Select ACLR measurement
:CALCulate:MARKer:FUNCtion:POWer:SELect ACPower

// Select MSR Standard :CALCulate:MARKer:FUNCtion:POWer:PRESet MSR
```

```
//Configure general measurement settings
:SENSe:FREQuency:CENTer 1.25GHz
:SENSe:FREQuency:SPAN 62.0MHz
:SENSe:POWer:ACHannel:SBCount 3

//----------------- Configuring Sub block A

:SENSe:POWer:ACHannel:SBLock1:TXCHannel:COUNt 3
:SENSe:POWer:ACHannel:SBLock1:FREQuency:CENTer 1.230GHZ
:SENSe:POWer:ACHannel:SBLock1:RFBWidth 12MHZ

:SENSe:POWer:ACHannel:SBLock1:CENTer:CHANnel1 1.226GHZ
:SENSe:POWer:ACHannel:SBLock1:CENTer:CHANnel2 1.230GHZ
:SENSe:POWer:ACHannel:SBLock1:CENTer:CHANnel3 1.234GHZ

:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel1 WCDMA
:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel2 WCDMA
:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel3 GSM


:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel1 2.5MHZ
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel2 2.5MHZ
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel3 2.5MHZ

//----------------- Configuring Sub block B

:SENSe:POWer:ACHannel:SBLock2:TXCHannel:COUNt 1
:SENSe:POWer:ACHannel:SBLock2:FREQuency:CENTer 1.255GHZ
:SENSe:POWer:ACHannel:SBLock2:RFBWidth 4MHZ

:SENSe:POWer:ACHannel:SBLock2:CENTer:CHANnel1 1.255GHZ

:SENSe:POWer:ACHannel:SBLock2:TECHnology:CHANnel1 LTE_1_40

:SENSe:POWer:ACHannel:SBLock2:BANDwidth:CHANnel1 3.25MHZ

//----------------- Configuring Sub block C

:SENSe:POWer:ACHannel:SBLock3:TXCHannel:COUNt 2
:SENSe:POWer:ACHannel:SBLock3:FREQuency:CENTer 1.268GHZ
:SENSe:POWer:ACHannel:SBLock3:RFBWidth 8MHZ

:SENSe:POWer:ACHannel:SBLock3:CENTer:CHANnel1 1.266GHZ
:SENSe:POWer:ACHannel:SBLock3:CENTer:CHANnel2 1.270GHZ


:SENSe:POWer:ACHannel:SBLock3:BANDwidth:CHANnel1 2.75MHZ
:SENSe:POWer:ACHannel:SBLock3:BANDwidth:CHANnel2 2.75MHZ

//----------------- Configuring ADJ channels
```

```
:SENSe:POWer:ACHannel:BANDwidth:ACHannel 1.60MHZ
:SENSe:POWer:ACHannel:BANDwidth:ALTernate1 1.60MHZ

:SENSe:POWer:ACHannel:SPACing:ACHannel 3MHZ
:SENSe:POWer:ACHannel:SPACing:ALTernate1 5MHZ

//----------------- Configuring gap (CACLR) channels

:SENSe:POWer:ACHannel:SPACing:GAP1 2.0MHZ
:SENSe:POWer:ACHannel:SPACing:GAP2 5.0MHZ

:SENSe:POWer:ACHannel:BANDwidth:GAP1 2.0MHZ
:SENSe:POWer:ACHannel:BANDwidth:GAP2 2.0MHZ

//--------------Performing the Measurement-----

//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and wait until the sweep has finished.
INIT;*WAI

//---------------Retrieving Results-------------

//Return the results for the ACLR measurement.
CALC:MARK:FUNC:POW:RES? MCAC
//Results:
//Transmission channels in sub block A
//-13.2346727385,-13.2346723793,-13.2390131759,
//Transmission channels in sub block B
//-17.0863336597,
//Transmission channels in sub block C
//-13.2390127767,-13.2390134744,
//Totals for each sub block
//-8.4649064021,-17.0863336597,-10.2287131689,
//Adjacent channels
//-67.9740721019,-67.9740728014,-0.00434041734,-0.00434041734,
//CACLR channels
//-0.52933512766,-64.9990115835,-64.5012521492,-0.33507330922,
//-64.4924159646,-0.52932552499,-0.52932552495,-64.4934163414
```

5.2.5 Measuring the Carrier-to-Noise Ratio

Useful commands to perform C/N measurements described elsewhere:

- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?` on page 408
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` on page 410
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe]` on page 410

- [SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>] on page 415
- [SENSe:]POWer:ACHannel:PRESet on page 411

Programming example: Measuring the carrier-to-noise ratio

```
//----------Preparing the measurement------------
*RST
//Reset the instrument
FREQ:CENT 800MHz
//Sets the center frequency to the carrier frequency of 800 MHz.
CALC:MARK:FUNC:POW:SEL CN
//Activates carrier-to-noise ratio measurement.
POW:ACH:PRES CN
//Optimizes the instrument settings according to the channel bandwidth.
POW:ACH:PRES:RLEV
//Determines the ideal reference level for the measurement.

//--------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.
// Now turn off the carrier signal and repeat the measurement:
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:POW:RES? CN
//Returns the carrier-to-noise ratio.
```

5.2.6 Measuring the Occupied Bandwidth

- Configuring the Measurement....448
- Programming Example: OBW Measurement....449

5.2.6.1 Configuring the Measurement

Useful commands to configure the channel described elsewhere:

- [SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>] on page 415
- [SENSe:]POWer:ACHannel:PRESet on page 411
- [SENSe:]POWer:ACHannel:PRESet:RLEVel on page 411

Useful commands to define search limits described elsewhere:

- CALCulate<n>:MARKer<m>:X:SLIMits:LEFT on page 631
- CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT on page 632

- CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] on page 632

Useful commands to perform the measurement described elsewhere:

- CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect on page 410
- CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe] on page 410

Useful commands to retrieve results described elsewhere:

- CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult? on page 408

[SENSe:]POWer:BANDwidth|BWIDth.....449

[SENSe:]POWer:BANDwidth|BWIDth <Percentage>

This command selects the percentage of the total power that defines the occupied bandwidth.

Parameters:

<Percentage> Range: 10 PCT to 99.9 PCT
*RST: 99 PCT

Example: `POW:BWID 95PCT`

Manual operation: See "% Power Bandwidth" on page 94

5.2.6.2 Programming Example: OBW Measurement

This programming example demonstrates the measurement example described in chapter 2.5.5, "Measurement Example", on page 96 in a remote environment.

```
//-------------Configuring the Measurement----------------------
*RST
//Resets the instrument
FREQ:CENT 800MHz
//Sets the center frequency to 800 MHz.
DISP:TRAC:Y:RLEV -10dBm
//Sets the reference level to -10 dBm.
CALC:MARK:FUNC:POW:SEL OBW
//Activates occupied bandwidth measurement.
POW:BWID 99PCT
//Sets the percentage of power to 99%.
POW:ACH:BAND 21kHz
//Sets the channel bandwidth to 21 kHz.
POW:ACH:PRES OBW
//Optimizes the instrument settings according to the channel bandwidth.
POW:ACH:PRES:RLEV
//Determines the ideal reference level for the measurement.
DET APE
//Sets the trace detector to positive peak.

//--------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
```

```
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:POW:RES? OBW
//Returns the occupied bandwidth.
```

5.2.7 Measuring with Spectrum Emission Masks

- Managing Measurement Configurations....450
- Controlling the Measurement....451
- Configuring Multi SEM Measurements....452
- Configuring Sweep Lists....454
- Configuring the Reference Range....467
- Configuring Power Classes....469
- Configuring MSR SEM Measurements....474
- Configuring the List Evaluation....479
- Performing SEM Measurements....481
- Retrieving Results....481
- Example: SEM Measurement....481

5.2.7.1 Managing Measurement Configurations

CALCulate<n>:LIMit<k>:ESPectrum<sb>:RESTore....450
[SENSe:]ESPectrum<sb>:PRESet[:STANdard]....450
[SENSe:]ESPectrum<sb>:PRESet:RESTore....451
[SENSe:]ESPectrum<sb>:PRESet:STORe....451

CALCulate<n>:LIMit<k>:ESPectrum<sb>:RESTore

This command restores the predefined limit lines for the selected Spectrum Emission Mask standard (<sb> is irrrelevant).

(<n>, <k> are irrelevant.)

All modifications made to the predefined limit lines are lost and the factory-set values are restored.

Example: `CALC:LIM:ESP:REST`
Resets the limit lines for the current Spectrum Emission Mask standard to the default setting.

[SENSe:]ESPectrum<sb>:PRESet[:STANdard] <Standard>

This command loads a measurement configuration.

Standard definitions are stored in an xml file. The default directory for SEM standards is `C:\r_s\instr\sem_std`.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<Standard> String containing the file name.
If you have stored the file in a subdirectory of the directory mentioned above, you have to include the relative path to the file.

Return values:
<Standard> The query returns the name of the currently loaded standard.

Manual operation: See "Standard / MSR Settings" on page 119
See "Load Standard" on page 126

[SENSe:]ESPectrum<sb>:PRESet:RESTore

This command restores the default configurations of predefined SEM standards.

Note that the command will overwrite customized standards that have the same name as predefined standards.

Suffix:
<sb> 1 | 2 | 3

Usage: Event

Manual operation: See "Restore Standard Files" on page 127

[SENSe:]ESPectrum<sb>:PRESet:STORe <Standard>

This command saves the current SEM measurement configuration.

Standard definitions are stored in an xml file. The default directory for SEM standards is `C:\r_s\instr\sem_std`.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<Standard> String containing the file name.
You can save the file in a subdirectory of the directory mentioned above. In that case, you have to include the relative path to the file.

Manual operation: See "Save Standard" on page 127

5.2.7.2 Controlling the Measurement

INITiate<n>:ESPectrum 451
[SENSe:]SWEep:MODE 452

INITiate<n>:ESPectrum

This command initiates a Spectrum Emission Mask measurement.

Suffix:
<n> irrelevant

Usage: Event

[SENSe:]SWEep:MODE <Mode>

This command selects the spurious emission and spectrum emission mask measurements.

You can select other measurements with

- `CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe]`

Parameters:
<Mode>

AUTO
Turns on basic spectrum measurements.

ESPectrum
Turns on spectrum emission mask measurements.

LIST
Turns on spurious emission measurements.

*RST: AUTO

Usage: SCPI confirmed

Manual operation: See "Spectrum Emission Mask" on page 15
See "Spurious Emissions" on page 15

5.2.7.3 Configuring Multi SEM Measurements

[SENSe:]ESPectrum<sb>:RANGe<range>:MLCalc 452
[SENSe:]ESPectrum<sb>:SBCENTER 453
[SENSe:]ESPectrum<sb>:SBCOUNT 453

[SENSe:]ESPectrum<sb>:RANGe<range>:MLCalc <Function>

Defines the function used to calculate the limit line for the n-th power class for overlapping ranges in Multi-SEM measurements. For details see "Limit calculation for individual ranges" on page 109.

Suffix:
<sb> 1 | 2 | 3

<range> 1..30
Selects the measurement range.

Parameters:

<Function>

NONE
(reference ranges only:) the limit of the reference range is used; Reference ranges always use the function "NONE".

SUM
sum of the two limit lines (calculated for linear powers) is used

MAX
maximum of the two limit lines is used

*RST: SUM (reference range: NONE)

Manual operation: See "Multi-Limit Calc <n>" on page 117

[SENSe:]ESPectrum<sb>:SBCENTER <Frequency>

This command defines the center frequency of the selected sub block in a Multi-SEM measurement.

Suffix:

<sb>

1 | 2 | 3
Sub block in a Multi-SEM measurement

Return values:

<Frequency>

Frequency within the currently defined global span (see `[SENSe:]FREQuency:SPAN` on page 572 and `[SENSe:]FREQuency:CENTer` on page 570).

Range: 1 to 3
*RST: 1

Example:

```
ESP2:SBCENTER 1GHZ
```

Manual operation: See "Sub Block Center Frequency" on page 119

[SENSe:]ESPectrum<sb>:SBCOUNT <Sub blocks>

This command defines the number of sub blocks in the SEM measurement. (<sb> is irrelevant)

Return values:

<Sub blocks>

Number of sub blocks in the SEM measurement.

Range: 1 to 3
*RST: 1

Example:

```
ESP:SBCOUNT 2
```

Manual operation: See "Sub Block Count" on page 119

5.2.7.4 Configuring Sweep Lists

Useful commands to configure sweep lists described elsewhere:

- `CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:LIMit[:STATe]` on page 471

[SENSe:]ESPectrum<sb>:HighSPeed 454
[SENSe:]ESPectrum<sb>:RANGe<range>:BANDwidth[:RESolution] 455
[SENSe:]ESPectrum<sb>:RANGe<range>:BANDwidth:VIDeo 455
[SENSe:]ESPectrum<sb>:RANGe<range>:COUNt? 455
[SENSe:]ESPectrum<sb>:RANGe<range>:DELete 456
[SENSe:]ESPectrum<sb>:RANGe<range>:FILTer:TYPE 456
[SENSe:]ESPectrum<sb>:RANGe<range>[:FREQuency]:STARt 456
[SENSe:]ESPectrum<sb>:RANGe<range>[:FREQuency]:STOP 457
[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:ATTenuation 457
[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:ATTenuation:AUTO 458
[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:GAIN 458
[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:GAIN:STATe 459
[SENSe:]ESPectrum<sb>:RANGe<range>:INSert 459
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:STARt 459
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:STOP 460
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt 461
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt:ABS 461
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt:FUNCtion 462
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP 462
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:ABSolute 463
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:FUNCtion 464
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:STATe 464
[SENSe:]ESPectrum<sb>:RANGe<range>:MLCalc 465
[SENSe:]ESPectrum<sb>:RANGe<range>:POINts:MIN[:VALue] 465
[SENSe:]ESPectrum<sb>:RANGe<range>:RLEVel 466
[SENSe:]ESPectrum<sb>:RANGe<range>:SWEep:TIME 466
[SENSe:]ESPectrum<sb>:RANGe<range>:SWEep:TIME:AUTO 466
[SENSe:]ESPectrum<sb>:RANGe<range>:TRANsducer 467

[SENSe:]ESPectrum<sb>:HighSPeed <State>

This command turns high speed mode for SEM measurements on and off.

For more information including restrictions see chapter 2.6.4.3, "Fast SEM Measurements", on page 106.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<State> ON | OFF
*RST: OFF

Example: `ESP:HSP ON`

Manual operation: See "Fast SEM" on page 114

[SENSe:]ESPectrum<sb>:RANGe<range>:BANDwidth[:RESolution] <RBW>

This command defines the resolution bandwidth for a SEM range.

In case of high speed measurements, the resolution bandwidth has to be identical for all ranges.

Suffix:
<sb> 1 | 2 | 3

<range> 1...30
Selects the measurement range.

Parameters:
<RBW> Resolution bandwidth.
Refer to the data sheet for available resolution bandwidths.
*RST: 30.0 kHz
Default unit: Hz

Manual operation: See "RBW" on page 114

[SENSe:]ESPectrum<sb>:RANGe<range>:BANDwidth:VIDeo <VBW>

This command defines the video bandwidth for a SEM range.

In case of high speed measurements, the video bandwidth has to be identical for all ranges.

Suffix:
<sb> 1 | 2 | 3

<range> 1...30
Selects the measurement range.

Parameters:
<VBW> Video bandwidth.
Refer to the data sheet for available video bandwidths.
*RST: 10.0 MHz
Default unit: Hz

Manual operation: See "VBW" on page 114

[SENSe:]ESPectrum<sb>:RANGe<range>:COUNt? <Ranges>

This command queries the number of ranges in the sweep list (<range> is irrelevant).

Suffix:
<sb> 1 | 2 | 3

Return values:
<Ranges> Number of ranges in the sweep list.

Usage: Query only

[SENSe:]ESPectrum<sb>:RANGe<range>:DELete

This command removes a range from the sweep list.

Note that

- you cannot delete the reference range
- a minimum of three ranges is mandatory.

Suffix:

<sb> 1 | 2 | 3

<range> 1...30
Selects the measurement range.

Usage: Event

Manual operation: See "Delete Range" on page 118

[SENSe:]ESPectrum<sb>:RANGe<range>:FILTer:TYPE <FilterType>

This command selects the filter type for an SEM range.

In case of high speed measurements, the filter has to be identical for all ranges.

Suffix:

<sb> 1 | 2 | 3

<range> 1...30
Selects the measurement range.

Parameters:

<FilterType>

CFILter
Channel filters
Available in the Spectrum application.

NORMal
3 dB Gaussian filters
Available in the Spectrum application.

P5
5-pole filters
Available for FFT sweeps in the Spectrum application.

RRC
RRC filters

*RST: Depends on application

Manual operation: See "Filter Type" on page 114

[SENSe:]ESPectrum<sb>:RANGe<range>[:FREQuency]:STARt <Frequency>

This command defines the start frequency of a SEM range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the SEM sweep list covers, the R&S FSWP will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the SEM sweep list covers, the R&S FSWP will adjust the start frequency of the first SEM range and the stop frequency of the last SEM range to the span

For more information see chapter 2.6.4.1, "Ranges and Range Settings", on page 102.

Suffix:
<sb> 1 | 2 | 3

<range> 1...30
Selects the measurement range.

Parameters:
<Frequency> Numeric value. Note that the minimum frequency range of a SEM range is 20 Hz.

*RST: -12.75 MHz (range 1), -2.515 MHz (range 2), 2.515 MHz (range 3)
Default unit: Hz

Manual operation: See "Range Start / Range Stop" on page 113

[SENSe:]ESPectrum<sb>:RANGe<range>[:FREQuency]:STOP <Frequency>

This command defines the stop frequency of a SEM range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the SEM sweep list covers, the R&S FSWP will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the SEM sweep list covers, the R&S FSWP will adjust the start frequency of the first SEM range and the stop frequency of the last SEM range to the span

For more information see chapter 2.6.4.1, "Ranges and Range Settings", on page 102.

Suffix:
<sb> 1 | 2 | 3

<range> 1...30
Selects the measurement range.

Parameters:
<Frequency> Numeric value.

*RST: -2.52 MHz (range 1), 2.52 MHz (range 2), 250.0 MHz (range 3)
Default unit: Hz

Manual operation: See "Range Start / Range Stop" on page 113

[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:ATTenuation <Attenuation>

This command defines the input attenuation for a SEM range.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

Suffix:
<sb> 1 | 2 | 3

<range> 1...20
Selects the measurement range.

Parameters:
<Attenuation> Numeric value.
Refer to the data sheet for the attenuation range.
*RST: 10 dB
Default unit: dB

Manual operation: See "RF Attenuator" on page 115

[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:ATTenuation:AUTO <State>

This command turns automatic selection of the input attenuation for a SEM range on and off.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

Suffix:
<sb> 1 | 2 | 3

<range> 1..30
Selects the measurement range.

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `ESP:RANG2:INP:ATT:AUTO OFF`
Deactivates the RF attenuation auto mode for range 2.

Manual operation: See "RF Att. Mode" on page 115

[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:GAIN <Gain>

This command selects the gain for a SEM range.

In case of high speed measurements, the level of the preamplifier has to be identical for all ranges.

Suffix:
<sb> 1 | 2 | 3

<range> 1..30
Selects the measurement range.

Parameters:

<Gain> 15 dB | 30 dB

The availability of gain levels depends on the R&S FSWP model.
• R&S FSWP8: 15 dB and 30 dB
• R&S FSWP26 or higher: 30 dB
All other values are rounded to the nearest of these two.

*RST: OFF

[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:GAIN:STATe <State>

This command turns the preamplifier for a SEM range on and off.

In case of high speed measurements, the state of the preamplifier has to be identical for all ranges.

Suffix:

<sb> 1 | 2 | 3

<range> 1..30
Selects the measurement range.

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "Preamp" on page 115

[SENSe:]ESPectrum<sb>:RANGe<range>:INSert <Mode>

This command inserts a new SEM range and updates the range numbers accordingly.

Suffix:

<sb> 1 | 2 | 3

<range> 1..30
Selects the SEM range.

Parameters:

<Mode> **AFTer**
Inserts a range after the selected range.

BEFore
Inserts a range before the selected range.

Manual operation: See "Insert before/after Range" on page 117

[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:STARt <Level>

This command defines an absolute limit for a SEM range.

Unlike manual operation, you can define an absolute limit anytime and regardless of the limit check mode.

Suffix:
<sb> 1 | 2 | 3

<range> 1..30
Selects the measurement range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:
<Level> Absolute limit at the start frequency of a SEM range.

Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESPectrum:RANGe:LIMit:ABSolute:STARt -10`
For a detailed example see chapter 5.2.7.11, "Example: SEM Measurement", on page 481.

Manual operation: See "Abs Limit Start/Stop <n>" on page 116

[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:STOP
<Level>

This command defines an absolute limit for a SEM range.

Unlike manual operation, you can define an absolute limit anytime and regardless of the limit check mode.

Suffix:
<sb> 1 | 2 | 3

<range> 1..30
Selects the measurement range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:
<Level> Absolute limit at the stop frequency of a SEM range.

Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESPectrum:RANGe:LIMit:ABSolute:STOP -15`
For a detailed example see chapter 5.2.7.11, "Example: SEM Measurement", on page 481.

Manual operation: See "Abs Limit Start/Stop <n>" on page 116

[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt <Limit>

This command defines a relative limit for a SEM range.

Unlike manual operation, you can define a relative limit regardless of the limit check mode.

Suffix:

<sb> 1 | 2 | 3

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Level> Relative limit at the start frequency of a SEM range.

Range: -400 to 400
*RST: -50
Default unit: dBc

Example: `SENS:ESP:RANG:LIM:REL:STAR -10`

Manual operation: See "Rel Limit Start/Stop <n>" on page 116

[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt:ABS <Limit>

This command defines an absolute limit for the MAX function of the relative limit for a SEM range.

For more information see "Relative limit line functions" on page 105.

Suffix:

<sb> 1 | 2 | 3

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the start frequency of a SEM range to be used in addition to the relative limit if the MAX function is enabled (see `[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt:FUNCtion` on page 462).

Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESPectrum:RANGe:LIMit:RELative:STARt:ABSolute -10`
For a detailed example see chapter 5.2.7.11, "Example: SEM Measurement", on page 481.

Manual operation: See "Rel Limit Start/Stop <n>" on page 116

[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt:FUNCtion <Function>

This command enables the use of a function when defining the relative limit for a SEM range.

Suffix:

<sb> 1 | 2 | 3

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Function> Defines the function to be used to determine the relative limit line start value

MAX
The maximum of the relative *and* the absolute level is used as the limit start value. Use the `[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt` and `[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt:ABS` commands to define these values.

OFF
No function is used, the relative limit line is defined by a fixed relative start value. Use the `[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt` command to define this value.

*RST: OFF

Example: `SENSe:ESPectrum:RANGe:LIMit:RELative:STARt:FUNCtion MAX`
For a detailed example see chapter 5.2.7.11, "Example: SEM Measurement", on page 481.

Manual operation: See "Rel Limit Start/Stop <n>" on page 116

[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP <Limit>

This command defines a relative limit for a SEM range.

Unlike manual operation, you can define a relative limit anytime and regardless of the limit check mode.

Suffix:
<sb> 1 | 2 | 3

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:
<Level> Relative limit at the stop frequency of a SEM range.

Range: -400 to 400
*RST: -50
Default unit: dBc

Example: `SENSe:ESPectrum:RANGe:LIMit:RELative:STOP -15`
For a detailed example see chapter 5.2.7.11, "Example: SEM Measurement", on page 481.

Manual operation: See "Rel Limit Start/Stop <n>" on page 116

[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:ABSolute <Limit>

This command defines an absolute limit for the MAX function of the relative limit for a SEM range.

For more information see "Relative limit line functions" on page 105.

Suffix:
<sb> 1 | 2 | 3

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:
<Level> Absolute limit at the stop frequency of a SEM range to be used in addition to the relative limit if the MAX function is enabled (see `[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:FUNCtion` on page 464).

Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESPectrum:RANGe:LIMit:RELative:STOP:ABSolute -15`
For a detailed example see chapter 5.2.7.11, "Example: SEM Measurement", on page 481.

Manual operation: See "Rel Limit Start/Stop <n>" on page 116

[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:FUNCtion <Function>

This command enables the use of a function when defining the relative limit for a SEM range.

Suffix:

<sb> 1 | 2 | 3

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Function> Defines the function to be used to determine the relative limit line stop value

MAX
The maximum of the relative *and* the absolute level is used as the limit stop value. Use the `[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP` and `[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:ABSolute` commands to define these values.

OFF
No function is used, the relative limit line is defined by a fixed relative stop value. Use the `[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP` command to define this value.

*RST: OFF

Example: `SENSe:ESPectrum:RANGe:LIMit:RELative:STOP:FUNCtion MAX`
For a detailed example see chapter 5.2.7.11, "Example: SEM Measurement", on page 481.

Manual operation: See "Rel Limit Start/Stop <n>" on page 116

[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:STATe <State>

This command selects the limit check mode for *all* SEM ranges (<range> is irrelevant).

Suffix:

<sb> 1 | 2 | 3

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<State> ABSolute | RELative | AND | OR

ABSolute
Checks only the absolute limits defined.

RELative
Checks only the relative limits. Relative limits are defined as relative to the measured power in the reference range.

AND
Combines the absolute and relative limit. The limit check fails when both limits are violated.

OR
Combines the absolute and relative limit. The limit check fails when one of the limits is violated.

*RST: RELative

Manual operation: See "Limit Check <n>" on page 116

[SENSe:]ESPectrum<sb>:RANGe<range>:MLCalc <Function>

Defines the function used to calculate the limit line for the n-th power class for overlapping ranges in Multi-SEM measurements. For details see "Limit calculation for individual ranges" on page 109.

Suffix:

<sb> 1 | 2 | 3

<range> 1..30
Selects the measurement range.

Parameters:

<Function> **NONE**
(reference ranges only:) the limit of the reference range is used; Reference ranges always use the function "NONE".

SUM
sum of the two limit lines (calculated for linear powers) is used

MAX
maximum of the two limit lines is used

*RST: SUM (reference range: NONE)

Manual operation: See "Multi-Limit Calc <n>" on page 117

[SENSe:]ESPectrum<sb>:RANGe<range>:POINts:MIN[:VALue] <SweepPoint>

Defines the minimum number of sweep points for the range.

Suffix:

<sb> 1 | 2 | 3

<range> 1..30
Selects the measurement range.

Parameters:

<SweepPoints> Minimum number of sweep points per range

Range: 1 to 32001
*RST: 1

Example: `SENSe1:ESPectrum:RANGe3:POINts:MIN:VALue 400`

Manual operation: See "Minimum Sweep Points" on page 117

[SENSe:]ESPectrum<sb>:RANGe<range>:RLEVel <RefLevel>

This command defines the reference level for a SEM range.

In case of high speed measurements, the reference level has to be identical for all ranges.

Suffix:

<sb> 1 | 2 | 3

<range> 1..30
Selects the measurement range.

Parameters:

<RefLevel> Reference level.
Refer to the data sheet for the reference level range.

*RST: 0 dBm

Manual operation: See "Ref. Level" on page 115

[SENSe:]ESPectrum<sb>:RANGe<range>:SWEep:TIME <SweepTime>

This command defines the sweep time for a SEM range.

In case of high speed measurements, the sweep time has to be identical for all ranges.

Suffix:

<sb> 1 | 2 | 3

<range> 1..30
Selects the measurement range.

Parameters:

<SweepTime> Sweep time.
The range depends on the ratios of the span to the RBW and the RBW to the VBW. Refer to the data sheet for more information.

Manual operation: See "Sweep Time" on page 115

[SENSe:]ESPectrum<sb>:RANGe<range>:SWEep:TIME:AUTO <State>

This command turns automatic selection of the sweep time for a SEM range on and off.

In case of high speed measurements, the sweep time has to be identical for all ranges.

Suffix:
<sb> 1 | 2 | 3

<range> 1..30
Selects the measurement range.

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `ESP:RANG3:SWE:TIME:AUTO OFF`
Deactivates the sweep time auto mode for range 3.

Manual operation: See "Sweep Time Mode" on page 114

[SENSe:]ESPectrum<sb>:RANGe<range>:TRANsducer <Transducer>

This command selects a transducer factor for a SEM range.

Note that

- the transducer must cover at least the span of the range
- the x-axis has to be linear
- the unit has to be dB

Suffix:
<sb> 1 | 2 | 3

<range> 1..30
Selects the measurement range.

Parameters:
<Transducer> String containing the transducer file name, including the path information.

Manual operation: See "Transd. Factor" on page 115

5.2.7.5 Configuring the Reference Range

[SENSe:]ESPectrum<sb>:BWID 467
[SENSe:]ESPectrum<sb>:FILTer[:RRC]:ALPHa 468
[SENSe:]ESPectrum<sb>:FILTer[:RRC][:STATe] 468
[SENSe:]ESPectrum<sb>:RRANge? 468
[SENSe:]ESPectrum<sb>:RTYPe 468

[SENSe:]ESPectrum<sb>:BWID <Bandwidth>

This command defines the channel bandwidth of the reference range.

The bandwidth is available if the power reference is the channel power.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<Bandwidth> minimum span ≤ value ≤ span of reference range
*RST: 3.84 MHz

Manual operation: See "Tx Bandwidth" on page 120

[SENSe:]ESPectrum<sb>:FILTer[:RRC]:ALPHa <Alpha>

This command defines the roll-off factor for the RRC filter.

The RRC filter is available if the power reference is the channel power.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<Alpha> Range: 0 to 1
*RST: 0.22

Manual operation: See "Alpha" on page 121

[SENSe:]ESPectrum<sb>:FILTer[:RRC][:STATe] <State>

This command turns the RRC filter in the reference range on and off.

The RRC filter is available if the power reference is the channel power.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Manual operation: See "RRC Filter State" on page 120

[SENSe:]ESPectrum<sb>:RRANge? <RefRange>

This command queries the reference range.

Suffix:
<sb> 1 | 2 | 3

Return values:
<RefRange> Number of the current reference range.
Range: 1 to 30

Usage: Query only

[SENSe:]ESPectrum<sb>:RTYPe <Type>

This command defines the type of the power reference.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<Type> **PEAK**
Measures the highest peak within the reference range.

CPOWer
Measures the channel power within the reference range (integral bandwidth method).

*RST: CPOWer

Manual operation: See "Power Reference Type" on page 120

5.2.7.6 Configuring Power Classes

CALCulate<n>:LIMit<k>:ESPectrum<sb>:LIMits....469
CALCulate<n>:LIMit<k>:ESPectrum<sb>:MODE....470
CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass:COUNt....471
CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:LIMit[:STATe]....471
CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:MAXimum....471
CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:MINimum....472
CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>[:EXCLusive]....473
CALCulate<n>:LIMit<k>:ESPectrum<sb>:VALue....473

CALCulate<n>:LIMit<k>:ESPectrum<sb>:LIMits <Max1>,<Max2>,<Max3>

This command sets or queries up to 4 power classes in one step. You can only define values for the number of power classes defined by `CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass:COUNt` on page 471.

(<n>, <k> are irrelevant.)

Suffix:
<sb> 1 | 2 | 3

Setting parameters:
<Max1> Defines the value range for power class 1 as `-200 to <Max1>`.
Only available for `CALC:LIM:ESP:PCL:COUNT >=2`
If only 2 power classes are defined, the value range for power class 2 is defined as `<Max1> to 200`.

Range: -199 to + 199

<Max2> Defines the value range for power class 2 as `<Max1> to <Max2>`.
Only available for `CALC:LIM:ESP:PCL:COUNT >=3`
If only 3 power classes are defined, the value range for power class 3 is defined as `<Max2> to 200`.

Range: -199 to + 199, <Max2> must be higher than <Max1>

<Max3> Defines the value range for power class 3 as `<Max2> to <Max3>`.
The value range for power class 4 is defined as `<Max3> to 200`.
Only available for `CALC:LIM:ESP:PCL:COUNT = 4`

Range: -199 to + 199, <Max3> must be higher than <Max2>

Return values:

<RangeLimits> As a result of the query, the range limits including the beginning of the first power class (-200) and the end of the last power class (+200) are indicated.

Example:
```
CALC:LIM:ESP:LIM -50,50,70
```
Defines the following power classes:
```
<-200, -50>
<-50, 50>
<50, 70>
<70, 200>
```
Query:
```
CALC:LIM:ESP:LIM?
```
Response:
```
-200,-50,50,70,200
```

CALCulate<n>:LIMit<k>:ESPectrum<sb>:MODE <Mode>

Which limit line is to be used for an SEM measurement depends on the power class the input signal power belongs to. This command defines wether the power class is determined automatically or manually.

(<n>, <k> are irrelevant.)

Suffix:

<sb> 1 | 2 | 3

Parameters:

<Mode>

AUTO
The power class (and thus the limit line) is assigned dynamically according to the currently measured channel power.

MANUAL
One of the specified power classes is selected manually for the entire measurement. The selection is made with the `CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>[:EXCLusive]` command.

*RST: AUTO

Example:
```
CALC:LIM:ESP:MODE AUTO
```
Activates automatic selection of the limit line.

CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass:COUNt <NoPowerClasses>

This command sets the number of power classes to be defined.

(<n>, <k> are irrelevant.)

This command must be executed before any new power class values can be defined using `CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:MAXimum` and `CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:MINimum`.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<NoPowerClasses> 1 to 4

*RST: 1

Example: `CALC:LIM:ESP:PCL:COUN 2`
Two power classes can be defined.

Manual operation: See "Adding or Removing a Power Class" on page 122

CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:LIMit[:STATe] <State>

This command selects the limit check mode for each power class.

(<n>, <k> are irrelevant.)

Suffix:
<sb> 1 | 2 | 3

<class> 1...4
power class

Parameters:
<State>

ABSolute
Evaluates only limit lines with absolute power values

RELative
Evaluates only limit lines with relative power values

AND
Evaluates limit lines with relative and absolute power values. A negative result is returned if both limits fail.

OR
Evaluates limit lines with relative and absolute power values. A negative result is returned if at least one limit failed.

*RST: REL

Example: `CALC:LIM:ESP:PCL:LIM ABS`

Manual operation: See "Used Power Classes" on page 121

CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:MAXimum <Level>

This command defines the upper limit of a particular power class.

(<n>, <k> are irrelevant.)

Note:

- The last power class always has an upper limit of 200 dBm.
- The upper limit of a power class must always be the same as the lower limit of the subsequent power class.
- The power class must already exist (see `CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass:COUNt` on page 471).

Suffix:

<sb> 1 | 2 | 3

<class> 1...4
power class

Parameters:

<Level> Range: -199.9 dBm to 200 dBm

Example: `CALC:LIM:ESP:PCL1:MAX -40 dBm`
Sets the maximum power value of the first power class to -40 dBm.

Manual operation: See "PMin/PMax" on page 122

CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:MINimum <Level>

This command defines the lower limit of a particular power class.

(<n>, <k> are irrelevant.)

Note:

- The first power class always has a lower limit of -200 dBm.
- The lower limit of a power class must always be the same as the upper limit of the previous power class.
- The power class must already exist (see `CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass:COUNt` on page 471).

Suffix:

<sb> 1 | 2 | 3

<class> 1...4
power class

Parameters:

<Level> Range: -200 dBm to 199.9 dBm

Example: `CALC:LIM:ESP:PCL2:MIN -40 dBm`
Sets the minimum power value of the second power class to -40 dBm.

Manual operation: See "PMin/PMax" on page 122

CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>[:EXCLusive] <State>

This command selects the power class used by the measurement if `CALCulate<n>:LIMit<k>:ESPectrum<sb>:MODE` is set to manual.

(<n>, <k> are irrelevant.)

Note that:

- You can only use power classes for which limits are defined.

Suffix:
<sb> 1 | 2 | 3

<class> 1...4
power class

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:LIM:ESP:PCL1 ON`
Activates the first defined power class.

Manual operation: See "Used Power Classes" on page 121

CALCulate<n>:LIMit<k>:ESPectrum<sb>:VALue <Power>

This command activates the manual limit line selection as and specifies the expected power as a value. Depending on the entered value, the associated predefined limit lines is selected.

(<n>, <k> are irrelevant.)

This command has the same effect as a combination of the CALC:LIM:ESP:MODE MAN and the `CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>[:EXCLusive]` commands; however, the power class to be used is not defined directly, but via the expected power. As opposed to `CALC:LIM:ESP:MODE AUTO`, the power class is not re-assigned to the input signal power dynamically, but only once when the command is executed.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<Power> integer
Range: -200 to 199
*RST: 0

Example: `CALC:LIM:ESP:VAL 33`
Activates manual selection of the limit line and selects the limit line for P = 33.

5.2.7.7 Configuring MSR SEM Measurements

[SENSe:]ESPectrum<sb>:MSR:APPLy 474
[SENSe:]ESPectrum<sb>:MSR:BAND 474
[SENSe:]ESPectrum<sb>:MSR:BCATegory 475
[SENSe:]ESPectrum<sb>:MSR:CLAS 476
[SENSe:]ESPectrum<sb>:MSR:GSM:CARR 476
[SENSe:]ESPectrum<sb>:MSR:GSM:CPResent 477
[SENSe:]ESPectrum<sb>:MSR:LTE:CPResent 478
[SENSe:]ESPectrum<sb>:MSR:MPOWer 478
[SENSe:]ESPectrum<sb>:MSR:RFBWidth 479

[SENSe:]ESPectrum<sb>:MSR:APPLy

This command configures the SEM sweep list according to the MSR settings defined by previous commands.

Suffix:
<sb> 1 | 2 | 3

Example:
```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Usage: Event

Manual operation: See "Apply to SEM" on page 125

[SENSe:]ESPectrum<sb>:MSR:BAND <Range>

Defines the frequency range of the bands used by the base station.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<Range>
LOW
≤ 3 GHz
HIGH
> 3 GHz
*RST: LOW

Example:

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Bands" on page 124

[SENSe:]ESPectrum<sb>:MSR:BCATegory <Category>

This command defines the band category for MSR measurements, i.e. the combination of available carriers to measure.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<Category> 1 | 2 | 3

1
2 carriers: LTE FDD and W-CDMA

2
3 carriers: LTE FDD, W-CDMA and GSM/EDGE

3
2 carriers: LTE TDD and TD-SCDMA

*RST: 1

Example:

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Band Category" on page 123

[SENSe:]ESPectrum<sb>:MSR:CLAS <Class>

Defines the class of the base station according to its sending range.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<Class>

WIDE
Wide Area

MEDium
Medium Range

LOCal
Local Area

*RST: WIDE

Example:

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Base Station Class" on page 123

[SENSe:]ESPectrum<sb>:MSR:GSM:CARR <Power>

Defines the power of the GSM carrier (if available, see `[SENSe:]ESPectrum<sb>:MSR:GSM:CPResent` on page 477).

This command is only available for band category 2 (see `[SENSe:]ESPectrum<sb>:MSR:BCATegory` on page 475).

Suffix:
<sb> 1 | 2 | 3

Parameters:
<Power> numeric value

Range: 0 dBm to 100 dBm
*RST: 39.0 dBm

Example:

```
//Select the band category 2
ESP2:MSR:BCAT BC2
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//GSM/Edge present
ESP2:MSR:GSM:CPR ON
//Power of the GSM carrier is 20dBm
ESP2:MSR:GSM:CARR 20
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Power GSM Carrier" on page 124

[SENSe:]ESPectrum<sb>:MSR:GSM:CPResent <State>

This command defines whether a GSM/Edge carrier is located at the edge of the specified RF bandwidth. In this case, the specification demands specific limits for the SEM ranges.

This command is only available for band category 2 (see `[SENSe:]ESPectrum<sb>:MSR:BCATegory` on page 475).

Suffix:
<sb> 1 | 2 | 3

Parameters:
<State> ON | OFF
*RST: OFF

Example:

```
//Select the band category 2
ESP2:MSR:BCAT BC2
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//GSM/Edge present
ESP2:MSR:GSM:CPR ON
//Power of the GSM carrier is 20dBm
ESP2:MSR:GSM:CARR 20
```

Manual operation: See "Carrier Adjacent to RF Bandwidth Edge" on page 124

[SENSe:]ESPectrum<sb>:MSR:LTE:CPResent <State>

This command defines whether an LTE FDD 1.4 MHz or 3 MHz carrier is located at the edge of the specified RF bandwidth. In this case, the specification demands specific limits for the SEM ranges.

This command is only available for band category 2 (see `[SENSe:]ESPectrum<sb>:MSR:BCATegory` on page 475).

Suffix:
<sb> 1 | 2 | 3

Parameters:
<State> ON | OFF
*RST: OFF

Example:
```
//Select the band category 2
ESP2:MSR:BCAT BC2
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//LTE present
ESP2:MSR:LTE:CPR ON
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Carrier Adjacent to RF Bandwidth Edge" on page 124

[SENSe:]ESPectrum<sb>:MSR:MPOWer <Power>

Defines the maximum output power of the base station.

This setting is only available for base stations with a medium range base station class (see `[SENSe:]ESPectrum<sb>:MSR:CLAS` on page 476).

Suffix:
<sb> 1 | 2 | 3

Parameters:
<Power> Range: 0 dBm to 100 dBm
Increment: 1 dB

Example:

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
```

Manual operation: See "Base Station Maximum Output Power" on page 124

[SENSe:]ESPectrum<sb>:MSR:RFBWidth <Bandwidth>

This command defines the RF bandwidth of the base station for MSR measurements.

Suffix:
<sb> 1 | 2 | 3

Parameters:
<Bandwidth> Bandwidth in Hz
*RST: 10.0 MHz

Example:

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Base Station RF Bandwidth" on page 124

5.2.7.8 Configuring the List Evaluation

CALCulate<n>:ESPectrum:PSEarch:AUTO 480
CALCulate<n>:ESPectrum:PEAKsearch:AUTO 480
CALCulate<n>:ESPectrum:PSEarch[:IMMediate] 480
CALCulate<n>:ESPectrum:PEAKsearch[:IMMediate] 480
CALCulate<n>:ESPectrum:PSEarch:MARGin 480
CALCulate<n>:ESPectrum:PEAKsearch:MARGin 480
CALCulate<n>:ESPectrum:PSEarch:PSHow 480
CALCulate<n>:ESPectrum:PEAKsearch:PSHow 480
MMEMory:STORe<n>:LIST 481

CALCulate<n>:ESPectrum:PSEarch:AUTO <State>
CALCulate<n>:ESPectrum:PEAKsearch:AUTO <State>

This command turns the list evaluation on and off.

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `CALC:ESP:PSE:AUTO OFF`
Deactivates the list evaluation.

Manual operation: See "List Evaluation (Result Summary) State" on page 128
See "List Evaluation State" on page 150

CALCulate<n>:ESPectrum:PSEarch[:IMMediate]
CALCulate<n>:ESPectrum:PEAKsearch[:IMMediate]

This command initiates a list evaluation.

Usage: Event

CALCulate<n>:ESPectrum:PSEarch:MARGin <Threshold>
CALCulate<n>:ESPectrum:PEAKsearch:MARGin <Threshold>

This command defines the threshold of the list evaluation.

Parameters:
<Margin> Range: -200 to 200
*RST: 200
Default unit: dB

Example: `CALC:ESP:PSE:MARG 100`
Sets the margin to 100 dB.

Manual operation: See "Margin" on page 128
See "Margin" on page 150

CALCulate<n>:ESPectrum:PSEarch:PSHow <State>
CALCulate<n>:ESPectrum:PEAKsearch:PSHow <State>

This command turns the peak labels in the diagram on and off.

Peak labels are blue squares.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:ESP:PSE:PSH ON`
Marks all peaks with blue squares.

Manual operation: See "Show Peaks" on page 128
See "Show Peaks" on page 150

MMEMory:STORe<n>:LIST <FileName>

This command exports the SEM and spurious emission list evaluation to a file.

The file format is *.dat.

Parameters:

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:LIST 'test'`
Stores the current list evaluation results in the `test.dat` file.

Manual operation: See "Saving the Result Summary (Evaluation List) to a File" on page 128
See "Saving the Evaluation List" on page 151

5.2.7.9 Performing SEM Measurements

Useful commands to perform SEM measurements described elsewhere:

- `INITiate<n>:ESPectrum` on page 451
- `INITiate<n>[:IMMediate]` on page 403
- `[SENSe:]SWEep:MODE` on page 452

5.2.7.10 Retrieving Results

Useful commands to retrieve results described elsewhere:

- `CALCulate<n>:LIMit<k>:FAIL?` on page 665
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?` on page 408
- `TRACe<n>[:DATA]` on page 606
- `TRACe<n>[:DATA]:MEMory?` on page 607
- `TRACe<n>[:DATA]:X?` on page 608

5.2.7.11 Example: SEM Measurement

In this example we will configure and perform an SEM measurement. Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task. For most common measurement standards, the R&S FSWP performs the measurement optimally with the predefined settings, without further configuration.

```
//------------ Preparing the measurement------------
*RST
//Resets the instrument
SWE:MODE ESP
//Activates SEM Measurement

INIT:CONT OFF
//Selects single sweep mode.
```

```
//SEM has to be in single sweep mode to be configured and no sweep operation
//may be running!
// If required, a sweep stop can be ensured by INIT:IMM;*WAI


//------------ Managing Measurement Configurations----------
ESP:PRES 'WCDMA\3GPP\UL\3GPP_UL.xml'
//Loads the 3GPP configuration stored in the file '3GPP_UL.xml'

//------------ Defining the Reference Range-----------------
ESP:RRAN?
//Queries the current reference range.
ESP:RTYP CPOW
//Selects the channel power as the power reference.
ESP:BWID 4 MHZ
//Defines a channel bandwidth of 4 MHz for the power reference.
ESP:FILT:RRC ON
ESP:FILT:ALPH 0.5
//Uses an RRC filter with a roll-off factor of 0.5 when measuring
//the reference power.

//------------ Configuring Power Classes--------------------
CALC:LIM:ESP:PCL:COUN 3
//Defines 3 power classes.
CALC:LIM:ESP:LIM -100,0
//Defines the value ranges of the three power classes as [dBm]:
//power class 1: -200 to -100
//power class 2: -100 to 0
//power class 3: 0 to 200
CALC:LIM:ESP:PCL1:LIM ABS
//Defines an absolute limit check for class 1.
CALC:LIM:ESP:PCL2:LIM REL
//Defines a relative limit check for class 2.
CALC:LIM:ESP:MODE MAN
//Defines a manual selection of the power class.
CALC:LIM:ESP:PCL2 ON
//Activates the use of the second power class for the entire measurement.

//------------ Configuring a Sweep List---------------------
ESP:RANG2:INS AFT
//Inserts a range after range 2.
ESP:RANG1:INS BEF
//Inserts a range before range 1.
ESP:RANG:COUNt?
//Returns the number of measurement ranges in the sweep list (currently 11).
ESP:RANG5:DEL

//Deletes the 11th range.
ESP:RANG1:STOP -10000000
```

```
//Defines a stop frequency of -9 MHz for range 1.
ESP:RANG2:STAR -9000000
//Defines a start frequency of -10 MHz for range 2.

ESP:HSP OFF
//Switches off Fast SEM mode so the ranges can be configured individually.

ESP:RANG2:BAND:RES 1000000
//Defines a resolution bandwidth of 1 MHz for range 2.

ESP:RANG2:FILT:TYPE RRC
//Selects an RRC filter for range 2.
ESP:RANG2:BAND:VID 5000000
//Defines a video bandwidth of 5 MHz for range 2.
ESP:RANG2:SWE:TIME 1
//Defines a sweep time of 1 second for range 2.
ESP:RANG2:RLEV 0
//Defines a reference level of 0 dBm for range 2.
ESP:RANG2:INP:ATT 10
//Defines an input attenuation of 10 dB for range 2.


// Create a transducer that can be used.
// It has to cover the corresponding frequency range

SENSe1:CORRection:TRANsducer:SELect 'Transducer'
SENSe1:CORRection:TRANsducer:UNIT 'DB'
SENSe1:CORRection:TRANsducer:COMMent 'Test Transducer'
// Frequency Span 0 MHz bis 20 Ghz
SENSe1:CORRection:TRANsducer:DATA 0e6,5, 20e9,3


ESP:RANG2:TRAN 'Transducer'
//Includes a transducer called 'transducer' for range 2.

//------------ Configuring the limit check------------------

ESP:RANG:LIM1:STAT AND
//Checks the absolute and relative limits for all ranges in power class 1 and
//fails if both limits are violated. Since power class 2 is set to be used for
//the entire measurement, values for Limit Check 1 are irrelevant. They are
//defined here to demonstrate the use of the MAX function for relative limits.
ESP:RANG2:LIM1:REL:STAR:FUNC MAX
//Enables the use of maximum function for relative limit start. If the value
//exceeds the larger of the absolute (-13 dBm) and relative (-10 dBc) start
//values, the check fails.
ESP:RANG2:LIM1:REL:STAR -10
ESP:RANG2:LIM1:REL:STAR:ABS -13
ESP:RANG2:LIM1:REL:STOP:FUNC MAX
```

```
ESP:RANG2:LIM1:REL:STOP -10
ESP:RANG2:LIM1:REL:STOP:ABS -13

ESP:RANG:LIM2:STAT OR
//Checks the absolute and relative limits for all ranges in power class 2 and
//fails if either limit is violated. Since power class 2 is set to be used for
//the entire measurement, values for Limit Check 1 are irrelevant.
ESP:RANG2:LIM2:ABS:STAR 10
ESP:RANG2:LIM2:ABS:STOP 10
//Defines an absolute limit of 10 dBm for the entire range 2 for power class 2.
ESP:RANG2:LIM2:REL:STAR -20
ESP:RANG2:LIM2:REL:STOP -20
//Defines a relative limit of -20 dBc for the entire range 2 for power class 2.

//------------ Configuring List Evaluation-----------------
CALC:ESP:PSE:AUTO ON
//Activates list evaluation, i.e. the peak is determined for each range
//after each sweep.
CALC:ESP:PSE:MARG 10dB
//Defines a peak threshold of 10 dB.

//------------ Managing Measurement Configurations----------

ESP:PRES:STOR 'WCDMA\3GPP\UL\3GPP_UL_User.xml'
//Saves the current configuration in a new file named '3GPP_UL_User'
//in the same directory so the standard is not overwritten.

//------------ Performing the measurement------------------
INIT:ESP
//One sweep

//------------ Checking the Results-------------------------
CALC:LIM:FAIL?
//Queries the result of the limit check for all ranges.
TRAC:DATA? LIST
//Returns the peak for each range of the SEM measurement as a list.
```

5.2.8 Measuring Spurious Emissions

- Initializing the Measurement 485
- Configuring Sweep Lists 485
- Configuring the List Evaluation 493
- Performing Spurious Emission Measurements 494
- Retrieving Results 495
- Programming Example: Spurious Emissions Measurement 495

5.2.8.1 Initializing the Measurement

Note that you have to initialize the measurement before you can configure the sweep list or the list evaluation.

INITiate<n>:SPURious 485

INITiate<n>:SPURious

This command initiates a Spurious Emission measurement.

Suffix:
<n> irrelevant

Usage: Event

5.2.8.2 Configuring Sweep Lists

In remote operation, it is not possible to configure the sweep list while a sweep is running.

Useful commands to configure sweep lists described elsewhere:

- `[SENSe:]SWEep:MODE` on page 452

[SENSe:]LIST:RANGe<range>:BANDwidth[:RESolution] 486
[SENSe:]LIST:RANGe<range>:BANDwidth:VIDeo 486
[SENSe:]LIST:RANGe<range>:BREak 486
[SENSe:]LIST:RANGe<range>:COUNt? 486
[SENSe:]LIST:RANGe<range>:DELete 487
[SENSe:]LIST:RANGe<range>:DETector 487
[SENSe:]LIST:RANGe<range>:FILTer:TYPE 487
[SENSe:]LIST:RANGe<range>[:FREQuency]:STARt 488
[SENSe:]LIST:RANGe<range>[:FREQuency]:STOP 488
[SENSe:]LIST:RANGe<range>:INPut:ATTenuation 489
[SENSe:]LIST:RANGe<range>:INPut:ATTenuation:AUTO 489
[SENSe:]LIST:RANGe<range>:INPut:GAIN:STATe 489
[SENSe:]LIST:RANGe<range>:INPut:GAIN[:VALue] 490
[SENSe:]LIST:RANGe<range>:LIMit:STARt 490
[SENSe:]LIST:RANGe<range>:LIMit:STATe 490
[SENSe:]LIST:RANGe<range>:LIMit:STOP 491
[SENSe:]LIST:RANGe<range>:POINts[:VALue] 491
[SENSe:]LIST:RANGe<range>:RLEVel 491
[SENSe:]LIST:RANGe<range>:SWEep:TIME 492
[SENSe:]LIST:RANGe<range>:SWEep:TIME:AUTO 492
[SENSe:]LIST:RANGe<range>:TRANsducer 492

[SENSe:]LIST:RANGe<range>:BANDwidth[:RESolution] <RBW>

This command defines the resolution bandwidth for a spurious emission measurement range.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<RBW> Resolution bandwidth.
Refer to the data sheet for available resolution bandwidths.
Default unit: Hz

Manual operation: See "RBW" on page 147

[SENSe:]LIST:RANGe<range>:BANDwidth:VIDeo <VBW>

This command defines the video bandwidth for a spurious emission measurement range.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<VBW> Video bandwidth.
Refer to the data sheet for available video bandwidths.
Default unit: Hz

Manual operation: See "VBW" on page 147

[SENSe:]LIST:RANGe<range>:BREak <State>

This command controls the sweep (for all ranges, <range> is irrelevant).

Parameters:
<State> **ON**
The R&S FSWP stops after measuring one range.
To continue with the next range, you have to use `INITiate<n>:CONMeas`.

OFF
The R&S FSWP sweeps all ranges in one go.

*RST: OFF

Manual operation: See "Stop After Sweep" on page 148

[SENSe:]LIST:RANGe<range>:COUNt?

This command queries the number of ranges in the sweep list (<range> is irrelevant).

Return values:
<Ranges> Number of ranges in the sweep list.

Usage: Query only

[SENSe:]LIST:RANGe<range>:DELete

This command removes a range from the sweep list.

Note that

- you cannot delete the reference range
- a minimum of three ranges is mandatory.

Suffix:
<range> 1..30
Selects the measurement range.

Usage: Event

[SENSe:]LIST:RANGe<range>:DETector <Detector>

This command selects the detector for a spurious emission measurement range.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<Detector> **NEGative**
minimum peak detector

POSitive
peak detector

SAMPle
sample detector

RMS
RMS detector

AVERage
average detector

*RST: RMS

Manual operation: See "Detector" on page 147

[SENSe:]LIST:RANGe<range>:FILTer:TYPE <FilterType>

This command selects the filter type for a spurious emission measurement range.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:

<FilterType>

CFILter
Channel filters
Available in the Spectrum application.

NORMal
3 dB Gaussian filters
Available in the Spectrum application.

P5
5-pole filters
Available for FFT sweeps in the Spectrum application.

RRC
RRC filters

*RST: Depends on application

Manual operation: See "Filter Type" on page 146

[SENSe:]LIST:RANGe<range>[:FREQuency]:STARt <Frequency>

This command defines the start frequency of a spurious emission measurement range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the sweep list covers, the R&S FSWP will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the sweep list covers, the R&S FSWP will adjust the start frequency of the first range and the stop frequency of the last range to the span

For more information see chapter 2.7, "Spurious Emissions Measurement", on page 141.

Suffix:

<range>

1..30
Selects the measurement range.

Parameters:

<Frequency>

Numeric value.

*RST: -12.75 MHz (range 1), -2.515 MHz (range 2), 2.515 MHz (range 3)

Default unit: Hz

Manual operation: See "Range Start / Range Stop" on page 146

[SENSe:]LIST:RANGe<range>[:FREQuency]:STOP <Frequency>

This command defines the stop frequency of a spurious emission measurement range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the sweep list covers, the R&S FSWP will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the sweep list covers, the R&S FSWP will adjust the start frequency of the first range and the stop frequency of the last range to the span

For more information seechapter 2.7, "Spurious Emissions Measurement", on page 141 .

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<Frequency> Numeric value.
*RST: -2.52 MHz (range 1), 2.52 MHz (range 2), 250.0 MHz (range 3)
Default unit: Hz

Manual operation: See "Range Start / Range Stop" on page 146

[SENSe:]LIST:RANGe<range>:INPut:ATTenuation <Attenuation>

This command defines the input attenuation for a spurious emission measurement range.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<Attenuation> Numeric value.
Refer to the data sheet for the attenuation range.
*RST: 10 dB
Default unit: dB

Manual operation: See "RF Attenuator" on page 148

[SENSe:]LIST:RANGe<range>:INPut:ATTenuation:AUTO <State>

This command turns automatic selection of the input attenuation for a spurious emission measurement range on and off.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Manual operation: See "RF Att. Mode" on page 148

[SENSe:]LIST:RANGe<range>:INPut:GAIN:STATe <State>

This command turns the preamplifier for a spurious emission measurement range on and off.

The preamplification is defined by `[SENSe:]LIST:RANGe<range>:INPut:GAIN[:VALue]` on page 490.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Preamp" on page 148

[SENSe:]LIST:RANGe<range>:INPut:GAIN[:VALue] <Gain>

This command selects the preamplification level for the range.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<Gain> 15 dB | 30 dB
The availability of gain levels depends on the R&S FSWP model.
• R&S FSWP8: 15dB and 30 dB
• R&S FSWP26 or higher: 30 dB
All other values are rounded to the nearest of these two.
*RST: OFF

[SENSe:]LIST:RANGe<range>:LIMit:STARt <Level>

This command defines an absolute limit for a spurious emission measurement range.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<Level> Absolute limit at the start frequency of a SEM range.
Range: -400 to 400
*RST: 13
Default unit: dBm

Manual operation: See "Abs Limit Start/Stop" on page 149

[SENSe:]LIST:RANGe<range>:LIMit:STATe

This command turns the limit check for all spurious emission measurement ranges on and off (<range> is irrelevant).

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Limit Check" on page 149

[SENSe:]LIST:RANGe<range>:LIMit:STOP <Level>

This command defines an absolute limit for a spurious emission measurement range.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<Level> Absolute limit at the stop frequency of a SEM range.
Range: -400 to 400
*RST: 13
Default unit: dBm

Manual operation: See "Abs Limit Start/Stop" on page 149

[SENSe:]LIST:RANGe<range>:POINts[:VALue] <Points>

This command defines the number of sweep points in a spurious emission measurement range.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<Points> For more information on sweep points see chapter 3.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 260.
*RST: 1001

Manual operation: See "Sweep Points" on page 148

[SENSe:]LIST:RANGe<range>:RLEVel <RefLevel>

This command defines the reference level for a spurious emission measurement range.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<RefLevel> Reference level.
Refer to the data sheet for the reference level range.
*RST: 0 dBm

Manual operation: See "Ref. Level" on page 147

[SENSe:]LIST:RANGe<range>:SWEep:TIME <SweepTime>

This command defines the sweep time for a spurious emission measurement range.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<SweepTime> Sweep time.
The range depends on the ratios of the span to the RBW and the RBW to the VBW. Refer to the data sheet for more information.

Manual operation: See "Sweep Time" on page 147

[SENSe:]LIST:RANGe<range>:SWEep:TIME:AUTO <State>

This command turns automatic selection of the sweep time for a spurious emission measurement range on and off.

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Manual operation: See "Sweep Time Mode" on page 147

[SENSe:]LIST:RANGe<range>:TRANsducer <Transducer>

This command selects a transducer factor for a spurious emission measurement range.

Note that

- the transducer must cover at least the span of the range
- the x-axis has to be linear
- the unit has to be dB

Suffix:
<range> 1..30
Selects the measurement range.

Parameters:
<Transducer> String containing the transducer file name, including the path information.

Manual operation: See "Transducer" on page 148

5.2.8.3 Configuring the List Evaluation

Useful commands to configure list evaluation described elsewhere:

- `MMEMory:STORe<n>:LIST` on page 481

CALCulate<n>:PSEarch:AUTO 493
CALCulate<n>:PEAKsearch:AUTO 493
CALCulate<n>:PSEarch:DETails 493
CALCulate<n>:ESPectrum:PEAKsearch:DETails 493
CALCulate<n>:PSEarch:MARGin 494
CALCulate<n>:PEAKsearch:MARGin 494
CALCulate<n>:PSEarch:PSHow 494
CALCulate<n>:PEAKsearch:PSHow 494
CALCulate<n>:PSEarch:SUBRanges 494
CALCulate<n>:PEAKsearch:SUBRanges 494

CALCulate<n>:PSEarch:AUTO <State>
CALCulate<n>:PEAKsearch:AUTO <State>

This command turns the list evaluation on and off.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example: `CALC:PSE:AUTO OFF`
Deactivates the list evaluation.

CALCulate<n>:PSEarch:DETails <State>
CALCulate<n>:ESPectrum:PEAKsearch:DETails <State>

This command configures how detailed the list in the Result Summary is.

Parameters:

<State> ON | OFF | 1 | 0

ON | 1
Includes all detected peaks (up to a maximum defined by `CALCulate<n>:PEAKsearch:SUBRanges` on page 494).

OFF | 0
Includes only one peak per range.

*RST: OFF

Example:
```
CALC:ESP:PSE:DET ON
CALC:PSE:SUBR 10
```
Includes up to 10 peaks per range in the list.

Usage: Event

Manual operation: See "Details" on page 150

CALCulate<n>:PSEarch:MARGin <Threshold>
CALCulate<n>:PEAKsearch:MARGin <Threshold>

This command defines the threshold of the list evaluation.

Parameters:
<Margin> Range: -200 to 200
*RST: 200
Default unit: dB

Example: `CALC:PSE:MARG 100`
Sets the threshold to 100 dB.

CALCulate<n>:PSEarch:PSHow <State>
CALCulate<n>:PEAKsearch:PSHow <State>

This command turns the peak labels in the diagram on and off.

Peak labels are blue squares.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:PSE:PSH ON`
Marks all peaks with blue squares.

CALCulate<n>:PSEarch:SUBRanges <NumberPeaks>
CALCulate<n>:PEAKsearch:SUBRanges <NumberPeaks>

This command defines the number of peaks included in the peak list.

After this number of peaks has been found, the R&S FSWP stops the peak search and continues the search in the next measurement range.

Parameters:
<NumberPeaks> Range: 1 to 50
*RST: 25

Example: `CALC:PSE:SUBR 10`
Sets 10 peaks per range to be stored in the list.

Manual operation: See "Peaks per Range" on page 151

5.2.8.4 Performing Spurious Emission Measurements

Useful commands to perform the measurement described elsewhere:

- `[SENSe:]SWEep:MODE` on page 452
- `INITiate<n>[:IMMediate]` on page 403

5.2.8.5 Retrieving Results

Useful commands to retrieve results described elsewhere:

- `CALCulate<n>:LIMit<k>:FAIL?` on page 665
- `TRACe<n>[:DATA]` on page 606
- `TRACe<n>[:DATA]:MEMory?` on page 607
- `TRACe<n>[:DATA]:X?` on page 608

MMEMory:STORe<n>:SPURious 495

MMEMory:STORe<n>:SPURious <FileName>

This command exports the marker peak list available for spurious emission measurements to a file.

The suffix <n> is irrelevant.

Parameters:

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:SPUR 'test'`
Saves the current marker peak list in the file test.dat.

Usage: Event

5.2.8.6 Programming Example: Spurious Emissions Measurement

In the following example, the Spurious Emissions measurement is configured by defining ranges and parameters to create the following sweep list.

Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task.

```
//------------Preparing the measurement-------------
*RST
//Resets the instrument

SWE:MODE LIST
//Activates spurious emissions measurement

INIT:CONT OFF
//Selects single sweep mode.

//Spurious measurement has to be in single sweep mode to be configured
//and no sweep operation may be running!

// If required, a sweep stop can be ensured by INIT:IMM;*WAI

//---------------Configuring a Sweep List----------

LIST:RANG:COUNt?
//Returns the number of measurement ranges in the sweep list.
```

```
LIST:RANG4:DEL
//Deletes the fourth range.
LIST:RANG1:STAR 10000000
//Defines a start frequency of 10 MHz for range 1.
LIST:RANG1:STOP 100000000
//Defines a stop frequency of 100 MHz for range 1.
LIST:RANG1:BAND 500000
//Defines a resolution bandwidth of 500 kHz in range 1.
LIST:RANG1:BAND:VID 5000000
//Defines a video bandwidth of 5 MHz for range 1.
LIST:RANG1:INP:ATT:AUTO OFF
//Turns automatic selection of the input attenuation in range 1 off.

LIST:RANG1:INP:ATT 10
//Defines a input attenuation of 10 dBm for range 1.


LIST:RANG1:FILT:TYPE CFILter
//Selects an Channel filter for range 1.
LIST:RANG1:DET SAMP
//Selects a sample detector for range 1.
LIST:RANG1:POIN 601
//Defines 601 sweep points for range 1.
LIST:RANG1:RLEV -20
//Defines a reference level of -20 dBm for range 1.
LIST:RANG1:SWE:TIME 5
//Defines a manual sweep time of 5 second for range 1.

// Create a transducer that can be used.
// It has to cover the corresponding frequency range
//
SENSe1:CORRection:TRANsducer:SELect 'Test'
SENSe1:CORRection:TRANsducer:UNIT 'DB'
SENSe1:CORRection:TRANsducer:COMMent 'Test Transducer'
// Frequency Span 0 MHz to 20 Ghz
SENSe1:CORRection:TRANsducer:DATA 0e6,5, 20e9,3

SENS:LIST:RANG1:TRAN 'Test'
//Includes a transducer called 'Test' for range 1.

LIST:RANG1:LIM:STAR 10
LIST:RANG1:LIM:STOP 10
//Defines an absolute limit of 10 dBm at the start and stop frequencies of range 1.
LIST:RANG:LIM:STAT ON
//Turns the limit check for all ranges on.

//---------------Configuring the List Evaluation----------
CALC:PSE:MARG 100
//Sets the threshold to 100 dB.
CALC:PSE:PSH ON
```

```
//Marks all peaks in the diagram with blue squares.
CALC:PSE:SUBR 10
//Sets 10 peaks per range to be stored in the list.

//--------------Performing the Measurement-----

INIT:SPUR; *WAI
//Performs a spurious emission measurement and waits until the sweep has finished.

//---------------Retrieving Results-------------
CALC:LIM1:FAIL?
//Queries the result of the check for limit line 1.
TRAC? SPUR
//Queries the peak list of the spurious emission measurement.
```

5.2.9 Analyzing Statistics

- Activating Statistical Measurements 497
- Configuring Statistical Measurements 498
- Using Gate Ranges for Statistical Measurements 499
- Scaling the Diagram 501
- Performing a Statistical Measurement 503
- Retrieving Results 503
- Programming Example: Measuring Statistics 505

5.2.9.1 Activating Statistical Measurements

CALCulate<n>:STATistics:APD[:STATe] 497
CALCulate<n>:STATistics:CCDF[:STATe] 497

CALCulate<n>:STATistics:APD[:STATe] <State>

This command turns the APD measurement on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:STAT:APD ON`
Switches on the APD measurement.

Manual operation: See "APD" on page 15

CALCulate<n>:STATistics:CCDF[:STATe] <State>

This command turns the CCDF on and off.

The suffix <n> is irrelevant.

Parameters:
<State> ON | OFF
*RST: OFF

Example: CALC:STAT:CCDF ON
Switches on the CCDF measurement.

Manual operation: See "CCDF" on page 16

5.2.9.2 Configuring Statistical Measurements

Useful commands to configure statistical measurements described elsewhere:

- [SENSe:]BANDwidth[:RESolution] on page 581

CALCulate<n>:MARKer<m>:Y:PERCent 498
CALCulate<n>:STATistics:NSAMples 498

CALCulate<n>:MARKer<m>:Y:PERCent <Probability>

This command sets a marker to a particular probability value. You can query the corresponding level with CALCulate<n>:MARKer<m>:X.

Using the command turns delta markers into normal markers.

This command is available for CCDF measurements.

Parameters:
<Probability> Range: 0 % to 100 %

Example: CALC1:MARK:Y:PERC 95PCT
Positions marker 1 to a probability of 95 %.

Manual operation: See "Percent Marker (CCDF only)" on page 160

CALCulate<n>:STATistics:NSAMples <Samples>

This command defines the number of samples included in the analysis of statistical measurement functions.

Parameters:
<Samples> Range: Min: 100, Max: depends on the RBW filter
*RST: 100000

Example: CALC:STAT:NSAM 500
Sets the number of measurement points to be acquired to 500.

Manual operation: See "Number of Samples" on page 161

5.2.9.3 Using Gate Ranges for Statistical Measurements

[SENSe:]SWEep:EGATe:TRACe<k>:COMMent....499
[SENSe:]SWEep:EGATe:TRACe:PERiod....499
[SENSe:]SWEep:EGATe:TRACe<k>:STARt<range>....499
[SENSe:]SWEep:EGATe:TRACe<k>:STOP<range>....500
[SENSe:]SWEep:EGATe:TRACe<k>[:STATe<range>]....500

[SENSe:]SWEep:EGATe:TRACe<k>:COMMent <Comment>

This command defines a comment for the gate of a particular trace.

Parameters:

<Comment> String containing the comment.

Example: `SWE:EGAT:TRAC1:COMM 'MyComment'`
Defines a comment for the gate in trace 1.

Manual operation: See "Comment" on page 162

[SENSe:]SWEep:EGATe:TRACe:PERiod <Length>

This command defines the length of the gate for all traces.

The gate length applies to all traces.

Parameters:

<Length> Range: 100 ns to 1000 s
*RST: 2 ms

Example: `SWE:EGAT:TRAC1:PER 5ms`
Defines the period for gated triggering to 5 ms.

Manual operation: See "Period" on page 162

[SENSe:]SWEep:EGATe:TRACe<k>:STARt<range> <Time>

This command defines the start time for a gate range.

Suffix:

<range> 1...3
gate range

Parameters:

<Time> The value range depends on the gate period you have set for the selected trace with `[SENSe:]SWEep:EGATe:TRACe:PERiod`. The following rules apply:
• the start time may not be higher than the length of the gate
• the start time may not be lower than the stop time of the gate range of a lower order
The reset values depend on the gate range.
• for gate range 1, the start time is 0 ms
• for gate range 3, the start time is 2 ms
• for gate range 5, the start time is 4 ms

Example: `SWE:EGAT:TRAC1:STAR1 3ms`
Sets the Starting point for range 1 on trace 1 at 3 ms.

Manual operation: See "Range <x> Start/Stop" on page 162

[SENSe:]SWEep:EGATe:TRACe<k>:STOP<range> <Time>

This command defines the stop time for a gate range.

Suffix:

<range> 1...3
gate range

Parameters:

<Time> The value range depends on the gate period you have set for the selected trace with `[SENSe:]SWEep:EGATe:TRACe:PERiod`. The following rules apply:
• the stop time may not be higher than the length of the gate
• the stop time may not be lower than the start time
The reset values depend on the gate range.
• for gate range 1, the stop time is 1 ms
• for gate range 3, the stop time is 3 ms
• for gate range 5, the stop time is 5 ms

Example: `SWE:EGAT:TRAC1:STOP1 5ms`
Sets the stopping point for range 1 on trace 1 at 5 ms.

Manual operation: See "Range <x> Start/Stop" on page 162

[SENSe:]SWEep:EGATe:TRACe<k>[:STATe<range>] <State>

This command includes or excludes a gate range for a particular trace.

Suffix:

<range> 1...3
gate range

Parameters:

<State> ON | OFF
*RST: OFF

Example: SWE:EGAT:TRAC1:STAT1 ON
Activates gate range 1 for trace 1.

Manual operation: See "Gated Trigger" on page 161
See "Range <x> Use" on page 162

5.2.9.4 Scaling the Diagram

CALCulate<n>:STATistics:PRESet 501
CALCulate<n>:STATistics:SCALe:AUTO ONCE 501
CALCulate<n>:STATistics:SCALe:X:RANGe 502
CALCulate<n>:STATistics:SCALe:X:RLEVel 502
CALCulate<n>:STATistics:SCALe:Y:LOWer 502
CALCulate<n>:STATistics:SCALe:Y:UNIT 503
CALCulate<n>:STATistics:SCALe:Y:UPPer 503

CALCulate<n>:STATistics:PRESet

This command resets the scale of the diagram (x- and y-axis).

- Reference level (x-axis)
  0.0 dBm
- Display range (x-axis) for APD measurements
  100 dB
- Display range (x-axis) for CCDF measurements
  20 dB
- Upper limit of the y-axis
  1.0
- Lower limit of the y-axis
  1E-6

Example: CALC:STAT:PRES
Resets the scaling for statistical functions

Usage: Event

Manual operation: See "Default Settings" on page 164

CALCulate<n>:STATistics:SCALe:AUTO ONCE

This command initiates an automatic scaling of the diagram (x- and y-axis).

To obtain maximum resolution, the level range is set as a function of the measured spacing between peak power and the minimum power for the APD measurement and of the spacing between peak power and mean power for the CCDF measurement. In addition, the probability scale for the number of test points is adapted.

To get valid results, you have to perform a complete sweep with synchronization to the end of the auto range process. This is only possible in single sweep mode.

Parameters:
ONCE

Example: CALC:STAT:SCAL:AUTO ONCE;*WAI
Adapts the level setting for statistical measurements.

Usage: Event

Manual operation: See "Adjust Settings" on page 161

CALCulate<n>:STATistics:SCALe:X:RANGe <Range>

This command defines the display range of the x-axis for statistical measurements.

The effects are identical to DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe].

Parameters:
<Range>
Range: 1 dB to 200 dB
*RST: 100 dB

Example: CALC:STAT:SCAL:X:RANG 20dB

Manual operation: See "Range" on page 164

CALCulate<n>:STATistics:SCALe:X:RLEVel <RefLevel>

This command sets the reference level for statistical measurements. The effects are identical to DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel.

Note that in case of statistical measurements the reference level applies to the x-axis.

Parameters:
<RefLevel>
The unit is variable.
If a reference level offset is included, the range is adjusted by that offset.
Range: -130 dBm to 30 dBm
*RST: 0 dBm

Example: CALC:STAT:SCAL:X:RLEV -60dBm

Manual operation: See "Ref Level" on page 164

CALCulate<n>:STATistics:SCALe:Y:LOWer <Magnitude>

This command defines the lower vertical limit of the diagram.

Parameters:
<Magnitude>
The number is a statistical value and therefore dimensionless.
Range: 1E-9 to 0.1
*RST: 1E-6

Example: CALC:STAT:SCAL:Y:LOW 0.001

Manual operation: See "Y-Max / Y-Min" on page 164

CALCulate<n>:STATistics:SCALe:Y:UNIT <Unit>

This command selects the unit of the y-axis.

Parameters:

<Unit> PCT | ABS
*RST: ABS

Example: `CALC:STAT:SCAL:Y:UNIT PCT`
Sets the percentage scale.

Manual operation: See "Y-Unit" on page 164

CALCulate<n>:STATistics:SCALe:Y:UPPer <Magnitude>

This command defines the upper vertical limit of the diagram.

Parameters:

<Magnitude> The number is a statistical value and therefore dimensionless.
Range: 1E-5 to 1.0
*RST: 1.0

Example: `CALC:STAT:SCAL:Y:UPP 0.01`

Manual operation: See "Y-Max / Y-Min" on page 164

5.2.9.5 Performing a Statistical Measurement

Useful commands to perform statistical measurements described elsewhere:

- `INITiate<n>[:IMMediate]` on page 403

5.2.9.6 Retrieving Results

Useful commands to retrieve results described elsewhere:

- `CALCulate<n>:MARKer<m>:X` on page 627

CALCulate<n>:STATistics:CCDF:X<t>? 503
CALCulate<n>:STATistics:RESult<t>? 504

CALCulate<n>:STATistics:CCDF:X<t>? <Probability>

This command queries the results of the CCDF.

Query parameters:

<Probability>

P0_01
Level value for 0.01 % probability

P0_1
Level value for 0.1 % probability

P1
P1: Level value for 1 % probability

P10
Level value for 10 % probability

Example: `CALC:STAT:CCDF:X1? P10`
Returns the level values that are over 10 % above the mean value.

Usage: Query only

Manual operation: See "CCDF" on page 16

CALCulate<n>:STATistics:RESult<t>? <ResultType>

This command queries the results of a CCDF or ADP measurement for a specific trace.

(<n> is irrelevant.)

Parameters:

<ResultType>

MEAN
Average (=RMS) power in dBm measured during the measurement time.

PEAK
Peak power in dBm measured during the measurement time.

CFACtor
Determined crest factor (= ratio of peak power to average power) in dB.

ALL
Results of all three measurements mentioned before, separated by commas: <mean power>,<peak power>,<crest factor>

Example: `CALC:STAT:RES2? ALL`
Reads out the three measurement results of trace 2. Example of answer string: 5.56,19.25,13.69 i.e. mean power: 5.56 dBm, peak power 19.25 dBm, crest factor 13.69 dB

Usage: Query only

Manual operation: See "APD" on page 15
See "CCDF" on page 16

5.2.9.7 Programming Example: Measuring Statistics

This example demonstrates how to determine statistical values for a measurement in a remote environment using the gated statistics example described in chapter 2.8.4, "APD and CCDF Basics - Gated Triggering", on page 158.

```
//-----------Configuring the measurement ------------
*RST
//Reset the instrument
TRIG:SOUR EXT
//Defines the use of an external trigger.
TRIG:HOLD 25us
//Defines a trigger offset of 25 µs.
CALC:STAT:APD ON
//Activates APD measurement.
CALC:STAT:NSAM 1000
//Sets the number of samples to be included in the statistical evaluation to 1000.

//-------------Defining Gate ranges -----------------

SWE:EGAT:TRAC1:COMM 'GSM - useful part'
//Defines a comment for the gate
SWE:EGAT:TRAC1:PER 4.61536ms
//Sets the gate period to 4.61536ms.
SWE:EGAT:TRAC1:STAR1 15us
//Sets the start of range 1 to 15 µs.
SWE:EGAT:TRAC1:STOP1 557.8us
//Sets the end of range 1 to 15 µs (start time) + 542.77 µs (useful part) = 557.8 µs.
SWE:EGAT:TRAC1:STAT1 ON
//Activates the use of range 1.

//--------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Retrieving Results-------------
CALC:STAT:RES1? MEAN
//Returns the mean average power for the useful part of the GSM signal.

//------------- Determining the CCDF values-------------------

CALC:STAT:CCDF ON
//Activates CCDF measurement.
CALC:MARK2:Y:PERC 95PCT
//Sets marker 2 to the 95% probability value.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.
CALC:STAT:CCDF:X? P1
```

```
//Returns the level value for 10% probability for the CCDF.
CALC:MARK2:X?
//Returns the level for a probability of 95%.


//----------- Scaling the diagram -------------------------
CALC:STAT:SCAL:X:RLEV -70dBm
//Sets the reference level to -70 dBm (x-axis!)
CALC:STAT:SCAL:X:RANG 20dB
//Defines a power level range of 20 dB for the x-axis
CALC:STAT:SCAL:Y:LOW 0.0001
//Sets the minimum of the y-axis to 0.01% probability
CALC:STAT:SCAL:Y:UPP 1.0
//Sets the maximum of the y-axis to 100% probability
CALC:STAT:SCAL:Y:UNIT PCT
//Displays percentage values on y-axis scale
```

5.2.10 Measuring the Time Domain Power

- Configuring the Measurement....506
- Performing Time Domain Power Measurements....509
- Retrieving Measurement Results....509
- Programming Example: Time Domain Power....513

5.2.10.1 Configuring the Measurement

Useful commands to configure the measurement described elsewhere:

- `CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 631
- `CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT` on page 632
- `CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 632

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AOFF.... 506
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage....507
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd.... 507
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary[:STATe].... 507
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN[:STATe]....508
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak[:STATe].... 508
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS[:STATe].... 508
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation[:STATe]....508

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AOFF

This command turns all time domain power evaluation modes off.

Usage: Event

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage <State>

This command switches on or off averaging for the active power measurement in zero span in the window specified by the suffix <n>. If activated, a time domain value is calculated from the trace after each sweep; in the end, all values are averaged to calculate the final result.

The number of results required for the calculation of average is defined with `[SENSe:]AVERage<n>:COUNt`.

Averaging is reset by switching it off and on again.

Synchronization to the end of averaging is only possible in single sweep mode.

Parameters:

<State> ON | OFF

*RST: OFF

Example:

```
INIT:CONT OFF
```
Switches to single sweep mode.
```
CALC:MARK:FUNC:SUMM:AVER ON
```
Switches on the calculation of average.
```
AVER:COUN 200
```
Sets the measurement counter to 200.
```
INIT;*WAI
```
Starts a sweep and waits for the end.

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd <State>

This command switches on or off the peak-hold function for the active power measurement in zero span in the window specified by the suffix <n>. If activated, the peak for each sweep is compared to the previously stored peak; the maximum of the two is stored as the current peak.

The peak-hold function is reset by switching it off and on again.

Parameters:

<State> ON | OFF

*RST: OFF

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary[:STATe] <State>

This command turns time domain power measurements on and off. This measurement in only available in zero span.

When you turn the measurement on, the R&S FSWP activates a marker and positions it on the peak power level in the marker search range.

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "Time Domain Power" on page 16

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN[:STATe] <State>

This command turns the evaluation to determine the mean time domain power on and off.

The R&S FSWP performs the measurement on the trace marker 1 is positioned on.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Results" on page 171

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak[:STATe] <State>

This command turns the evaluation to determine the positive peak time domain power on and off.

The R&S FSWP performs the measurement on the trace marker 1 is positioned on.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Results" on page 171

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS[:STATe] <State>

This command turns the evaluation to determine the RMS time domain power on and off.

The R&S FSWP performs the measurement on the trace marker 1 is positioned on.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Results" on page 171

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation[:STATe] <State>

This command turns the evaluation to determine the standard deviation of the time domain power on and off.

The R&S FSWP performs the measurement on the trace marker 1 is positioned on.

Parameters:
<State> ON | OFF
*RST: OFF

5.2.10.2 Performing Time Domain Power Measurements

Useful commands to perform time domain power measurements described elsewhere:

- `INITiate<n>[:IMMediate]` on page 403

5.2.10.3 Retrieving Measurement Results

- Mean Power....509
- Peak Power....510
- RMS Power....511
- Standard Deviation....512

Mean Power

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:AVERage:RESult?....509
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:PHOLd:RESult?.... 509
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:RESult?....509

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:AVERage:RESult?

This command queries the average mean time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 507.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:

<MeanPower> Mean power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:PHOLd:RESult?

This command queries the maximum mean time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:

<MeanPower> Mean power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:RESult?

This command queries the mean time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:
<MeanPower> Mean power of the signal during the measurement time.

Usage: Query only

Manual operation: See "Results" on page 171

Peak Power

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:AVERage:RESult? 510
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:PHOLd:RESult? 510
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:RESult? 510

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:AVERage:RESult?

This command queries the average positive peak time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 507.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Parameters:
<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:PHOLd:RESult?

This command queries the maximum positive peak time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Parameters:
<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:RESult?

This command queries the positive peak time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Parameters:
<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

Manual operation: See "Results" on page 171

RMS Power

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:AVERage:RESult?.....511
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:PHOLd:RESult?.....511
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:RESult?.....511

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:AVERage:RESult?

This command queries the average RMS of the time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 507.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:
<RMSPower> RMS power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:PHOLd:RESult?

This command queries the maximum RMS of the time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:
<RMSPower> RMS power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:RESult?

This command queries the RMS of the time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:
<RMSPower> RMS power of the signal during the measurement time.

Usage: Query only

Manual operation: See "Results" on page 171

Standard Deviation

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:AVERage:RESult?.....512
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:PHOLd:RESult?..... 512
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:RESult?.....512

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:AVERage:RESult?

This command queries the average standard deviation of the time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 507.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:
<StandardDeviation> Standard deviation of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:PHOLd:RESult?

This command queries the maximum standard deviation of the time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:
<StandardDeviation> Standard deviation of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:RESult?

This command queries the standard deviation of the time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:
<StandardDeviation> Standard deviation of the signal during the measurement time.

Usage: Query only

5.2.10.4 Programming Example: Time Domain Power

This programming example demonstrates the measurement example described in chapter 2.9.6, "Measurement Example", on page 172 in a remote environment.

```
//-------------Configuring the Measurement----------------------
*RST
//Resets the instrument

INIT:CONT OFF
//Turns on single sweep mode.

FREQ:CENT 1.8GHz
//Sets the center frequency to 1.8 GHz.

BAND:RES 100kHz
//Sets the bandwidth to 100 kHz.

SWE:TIME 10ms
//Sets the sweep time to 640 µs.

FREQ:SPAN 0
//Sets the instrument to zero span.


CALC:MARK:FUNC:SUMM:STAT ON
//Turns on time domain power measurements.

CALC:MARK:FUNC:SUMM:MEAN ON
CALC:MARK:FUNC:SUMM:PPE ON
CALC:MARK:FUNC:SUMM:RMS ON
//Turns the evalution of the mean, peak and RMS time domain power.

CALC:MARK:X:SLIM ON
//Activates limit lines for evaluation.

CALC:MARK:X:SLIM:LEFT 1ms
//Sets the left limit line to 326 µs.

CALC:MARK:X:SLIM:RIGH 6ms
//Sets the right limit line to 538 µs.

//--------------Performing the Measurement-----------------------

INIT;*WAI
//Initiates the measurement and waits until the measurement is finished.

//-------------Retrieving the Results--------------------------------
CALC:MARK:FUNC:SUMM:MEAN:RES?
CALC:MARK:FUNC:SUMM:PPE:RES?
```

```
CALC:MARK:FUNC:SUMM:RMS:RES?
//Queries the mean, peak and RMS time domain power.
```

5.2.11 Measuring the Harmonic Distortion

- Activating the Measurement....514
- Configuring the Measurement....514
- Performing the Measurement....515
- Retrieving Results....515
- Example: Measuring the Harmonic Distortion....516

5.2.11.1 Activating the Measurement

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics[:STATe]..... 514

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics[:STATe] <State>

This command turns the harmonic distortion measurement on and off.

Note the following:

- If you perform the measurement in the frequency domain, the search range for the frequency of the first harmonic, whose power is determined, is defined by the last span.
- If you perform the measurement in the time domain, the current center frequency is used as the frequency of the first harmonic. Thus, the frequency search is bypassed. The first harmonic frequency is set by a specific center frequency in zero span before the harmonic measurement is started.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:FUNC:HARM ON`
Activates the harmonic distortion measurement.

Manual operation: See "Harmonic Distortion" on page 16

5.2.11.2 Configuring the Measurement

Useful commands to configure the measurements described elsewhere:

- `CALCulate<n>:MARKer<m>:FUNCtion:CENTer` on page 573
- `[SENSe:]SWEep:TIME:AUTO` on page 588

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:BANDwidth:AUTO....515
CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:NHARmonics....515
CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:PRESet....515

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:BANDwidth:AUTO <State>

This command selects the resolution bandwidth of the harmonic in respect to the bandwidth of the first harmonic.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
identical

ON | 1
a multiple

*RST: 1

Manual operation: See "Harmonic RBW Auto" on page 178

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:NHARmonics <NoHarmonics>

This command selects the number of harmonics that the R&S FSWP looks for.

Parameters:

<NoHarmonics> Range: 1 to 26
*RST: 10

Manual operation: See "No. of Harmonics" on page 178

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:PRESet

This command initiates a measurement to determine the ideal configuration for the harmonic distortion measurement.

The method depends on the span.

- Frequency domain (span > 0)
  Frequency and level of the first harmonic are determined and used for the measurement list.
- Time domain (span = 0)
  The level of the first harmonic is determined. The frequency remains unchanged.

Usage: Event

Manual operation: See "Adjust Settings" on page 179

5.2.11.3 Performing the Measurement

Useful commands to perform the measurement described elsewhere:

- `INITiate<n>[:IMMediate]` on page 403

5.2.11.4 Retrieving Results

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:DISTortion? 516
CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:LIST? 516

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:DISTortion? TOTal

This command queries the total harmonic distortion of the signal.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:

<Result> <Distortion_%>,<Distortion_dB>
Pair of values, one showing the THD in %, one in dB.

Usage: Query only

Manual operation: See "Harmonic Distortion" on page 16

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:LIST?

This command queries the position of the harmonics.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:

<Harmonics> Returns one value for every harmonic.
The first value is the absolute power of the first harmonic. The unit is variable.
The other values are power levels relative to the first harmonic. The unit for these is dB.

Usage: Query only

Manual operation: See "Harmonic Distortion" on page 16

5.2.11.5 Example: Measuring the Harmonic Distortion

```
//-------------Configuring the Measurement-------------
*RST
//Resets the instrument.

INIT:CONT OFF
//Turns on single sweep mode.

CALC:MARK:FUNC:HARM ON
//Turns on the harmonic distortion measurement.
CALC:MARK:FUNC:HARM:NHAR 3
//Defines three harmonics to be found.

CALC:MARK:FUNC:HARM:BAND:AUTO OFF
//Turns off automatic bandwidth selection.
CALC:MARK:FUNC:HARM:PRES
//Determines the ideal configuration.
```

```
//-------------Performing the Measurement-------------------

INIT;*WAI
//Initiates the measurement and finishes the sweep.

//-------------Retrieving the Results------------------------
CALC:MARK:FUNC:HARM:LIST?
//Queries the position of the harmonics.
CALC:MARK:FUNC:HARM:DIST? TOT
//Queries the total harmonic distortion.
```

5.2.12 Measuring the Third Order Intercept Point

- Determining the TOI....517
- Programming Example: Measuring the TOI....518

5.2.12.1 Determining the TOI

Useful commands to perform TOI measurements described elsewhere:

- `CALCulate<n>:DELTamarker<m>:X` on page 625
- `CALCulate<n>:DELTamarker<m>:X:RELative?` on page 638
- `CALCulate<n>:DELTamarker<m>:Y?` on page 639
- `CALCulate<n>:MARKer<m>:X` on page 627
- `CALCulate<n>:MARKer<m>:Y?` on page 639

CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult?.... 517
CALCulate<n>:MARKer<m>:FUNCtion:TOI:SEARchsignal ONCE.... 518
CALCulate<n>:MARKer<m>:FUNCtion:TOI[:STATe].... 518

CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult?

This command queries the results for the third order intercept point measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Parameters:

<TOI> Third order intercept point.

Example:

```
INIT:CONT OFF
```
Switches to single sweep mode.
```
CALC:MARK:FUNC:TOI ON
```
Switches the intercept measurement.
```
INIT;*WAI
```
Starts a sweep and waits for the end.
```
CALC:MARK:FUNC:TOI:RES?
```
Outputs the measured value.

Usage: Query only

Manual operation: See "TOI" on page 16

CALCulate<n>:MARKer<m>:FUNCtion:TOI:SEARchsignal ONCE

This command initiates a search for signals in the current trace to determine the third intercept point.

(<n>,<m> are irrelevant.)

Parameters:
ONCE

Example: `CALC:MARK:FUNC:TOI:SEAR ONCE`
Executes the search for 2 signals and their intermodulation product at the currently available trace.

Usage: Event

Manual operation: See "Search Signals" on page 186

CALCulate<n>:MARKer<m>:FUNCtion:TOI[:STATe] <State>

This command initiates a measurement to determine the third intercept point.

A two-tone signal with equal carrier levels is expected at the RF input of the instrument. Marker 1 and marker 2 (both normal markers) are set to the maximum of the two signals. Delta marker 3 and delta marker 4 are positioned to the intermodulation products. The delta markers can be modified separately afterwards with the `CALCulate<n>:DELTamarker<m>:X` command.

The third-order intercept is calculated from the level spacing between the normal markers and the delta markers.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:MARK:FUNC:TOI ON`
Switches on the measurement of the third-order intercept.

Manual operation: See "TOI" on page 16

5.2.12.2 Programming Example: Measuring the TOI

This example demonstrates how to determine the TOI in a remote environment.

```
//-----------Configuring the measurement ------------
*RST
//Reset the instrument
CALC:MARK:FUNC:TOI ON
//Activate TOI measurement.
```

```
//--------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.

CALC:MARK:FUNC:TOI:SEAR ONCE
//Initiates a search for signals in the current trace.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:TOI:RES?
//Returns the TOI.
```

5.2.13 Measuring the AM Modulation Depth

- Configuring and Performing the Measurement 519
- Example: Measuring the AM Modulation Depth 520

5.2.13.1 Configuring and Performing the Measurement

Useful commands to perform AM modulation depth measurements described elsewhere:

- `CALCulate<n>:DELTamarker<m>:X` on page 625
- `CALCulate<n>:DELTamarker<m>:X:RELative?` on page 638
- `CALCulate<n>:MARKer<m>:X` on page 627

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:RESult? 519
CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:SEARchsignal ONCE 519
CALCulate<n>:MARKer<m>:FUNCtion:MDEPth[:STATe] 520

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:RESult?

This command queries the results of the AM modulation depth measurement..

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:

<ModulationDepth> Modulation depth in %.

Usage: Query only

Manual operation: See "AM Mod Depth" on page 16

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:SEARchsignal ONCE

This command initiates a search for the signals required for the AM depth measurement.

Note that the command does not perform a new measurement, but looks for the signals on the current trace.

Parameters:
ONCE

Example: `CALC:MARK:FUNC:MDEP:SEAR ONCE`
Executes the search of an AM modulated signal at the currently available trace.

Usage: Event

Manual operation: See "Search Signals" on page 191

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth[:STATe] <State>

This command turns the AM Modulation Depth measurement on and off.

To work correctly, the measurement requires an AM modulated signal.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "AM Mod Depth" on page 16

5.2.13.2 Example: Measuring the AM Modulation Depth

This example demonstrates how to determine the AM modulation depth in a remote environment. Note that without a real input signal this measurement will not return useful results.

```
//-----------Configuring the measurement ------------
*RST
//Reset the instrument
FREQ:CENT 100MHz
//Set center frequency
FREQ:SPAN 10KHz
// Set span
CALC:MARK:FUNC:MDEP ON
//Activate AM modulation depth measurement.

//--------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT:IMM
// Perform a single measurement
CALC:MARK:FUNC:MDEP:SEAR ONCE
//Initiates a search for signals in the current trace.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:MDEP:RES?
//Queries the measurement results.

//If the results are not accurate, change the position of the
```

```
//the temporary markers manually.

//----Changing the position of the temp markers-----
CALC:MARK:X 100MHZ
//Positions the reference marker on 100 MHz.
CALC:DELT2:X 5KHZ
//Positions delta marker 2 and 3 at a distance of 5 kHz to the reference marker.
CALC:DELT3:X 1KHZ
//Corrects the position of delta marker 3 by 1 kHz.

CALC:MARK:FUNC:MDEP:RES?
//Queries the measurement results for the repositioned markers.
```

5.2.14 List Evaluations

A list evaluation is a multiple power measurement that measures the power at up to 200 frequencies. The measurement itself is a time domain measurement. Note that if you set a span greater than 0, the R&S FSWP aborts the list evaluation.

Noise cancellation in list evaluations

Noise cancellation is also available in zero span and thus also for list evaluations. See "Noise cancellation" on page 56 for details.

In case of a triggered measurement, a separate trigger event is required for each frequency to initiate that measurement. Note that you have to make changes to the trigger level in the time domain in order for it to take effect for the List Evaluation commands.

The list evaluation is incompatible to other measurement functions (e.g. marker functionality or statistics). If you use a command that controls those functions, the R&S FSWP aborts the list evaluation.

The R&S FSWP also aborts the list evaluation if you end the remote session.

The commands can be used in two different ways.

- Instrument setup, measurement and querying of the results in a single command line. This method causes the least delay between the measurement and the result output. However, it requires the control computer to wait for the response from the instrument.
- Instrument setup and querying of the result list at the end of the measurement: With this method, the control computer may be used for other activities while the measurement is being performed. However, more time is needed for synchronization via service request.

5.2.14.1 Performing List Evaluations

All remote control commands specific to list evaluations (which are available via remote control only) are described here.

Useful commands for list evaluation described elsewhere:

- `[SENSe:]POWer:NCORrection` on page 575

Remote commands exclusive to list evaluation

[SENSe:]LIST:POWer:RESult? 522
[SENSe:]LIST:POWer[:SEQuence] 522
[SENSe:]LIST:POWer:SET 523
[SENSe:]LIST:POWer:STATe 524

[SENSe:]LIST:POWer:RESult?

This command queries the results of the list evaluation.

This command may be used to obtain measurement results in an asynchronous way, using the service request mechanism for synchronization to the end of the measurement.

If there are no results, the command returns an error.

Return values:

<PowerLevel> Power level for each frequency included in the measurement. The command returns up to 3 power levels for each frequency, depending on the number of evaluation modes you have turned on with `[SENSe:]LIST:POWer:SET`.
The result is a list of floating point values separated by commas. The unit depends on `CALCulate<n>:UNIT:POWer`.

Usage: Query only

[SENSe:]LIST:POWer[:SEQuence] <Frequency>, <RefLevel>, <RFAttenuation>, <FilterType>, <RBW>, <VBW>, <MeasTime>, <TriggerLevel>

This command configures and initiates the List Evaluation measurement.

The list can contain up to 200 entries (frequencies). You can define a different instrument setup for each frequency that is in the list.

If you synchronize the measurement with `*OPC`, the R&S FSWP produces a service request when all frequencies have been measured and the number of individual measurements has been performed.

Note that using the command as a query initiates the measurement and returns the results if all frequencies have been measured. For more information on querying the results see `[SENSe:]LIST:POWer:RESult?`.

Parameters:

<Frequency> Defines the frequency. Each frequency corresponds to one list entry.
Range: 0 to Fmax
Default unit: Hz

<RefLevel> Defines the reference level for a list entry.
Range: -130 to 30
Increment: 0.01
Default unit: dBm

<RFAttenuation> Defines the RF attenuation for a list entry.
Range: 0 to 70
Increment: 1
Default unit: dB

<FilterType> Selects the filter type for a list entry. For more information see `[SENSe:]BANDwidth[:RESolution]:TYPE`.

<RBW> Defines the resolution bandwidth for a list entry.

<VBW> Defines the video bandwidth for a list entry.

<MeasTime> Defines the measurement time for a list entry.
Range: 1 µs to 16000 s

<TriggerLevel> The trigger level must be 0.

Return values:

<PowerLevel> Power level for each frequency included in the measurement. The command returns up to 3 power levels for each frequency, depending on the number of evaluation modes you have turned on with `[SENSe:]LIST:POWer:SET`.
The result is a list of floating point values separated by commas. The unit depends on `CALCulate<n>:UNIT:POWer`.

[SENSe:]LIST:POWer:SET <PeakPower>, <RMSPower>, <AVGPower>, <TriggerSource>, <TriggerSlope>, <TriggerOffset>, <GateLength>

This command defines global List Evaluation parameters.

These parameters are valid for every frequency you want to measure.

The state of the first three parameters (<PeakPower>, <RMSPower> and <AVG-Power>) define the number of results for each frequency in the list.

Note that you have to set the trigger level *after* sending this command.

Parameters:

<PeakPower> ON | OFF | 0 | 1
Turns peak power evaluation on and off.
*RST: 1

<RMSPower> ON | OFF | 0 | 1
Turns RMS power evaluation on and off.
*RST: 0

<AVGPower> ON | OFF | 0 | 1
Turns average power evaluation on and off.
*RST: 0

<TriggerSource> Selects a trigger source.

<TriggerSlope> NEGative | POSitive
Selects the trigger slop.

<TriggerOffset> Defines the trigger delay.
Range: negative measurement time to 30 s
*RST: 0
Default unit: s

<GateLength> Defines the gate length for gated measurements.
Setting 0 seconds turns gated measurements off.
To perform gated measurements, the trigger source must be different from `IMMediate`.
Range: 31.25 ns to 30 s
*RST: 0 s

[SENSe:]LIST:POWer:STATe <State>

This command turns the List Evaluation off.

Parameters:
<State> OFF
*RST: OFF

5.2.14.2 Example: Performing List Evaluation

The following example shows a list evaluation with the following configuration.

No	Freq [MHz]	Ref Level [dBm]	RF Attenuation [dB]	EI Attenuation [dB]	Filter	RBW	VBW	Meas Time	Trigger Level
1	935.2	0	10	---	Normal	1 MHz	3 MHz	440 µs	0
2	935.4	0	10	10	Channel	30 kHz	100 kHz	440 µs	0
3	935.6	0	10	20	Channel	30 kHz	100 kHz	440 µs	0

```
-----Measurement with synchronization via service request-----
*ESE 1
*SRE 32
```

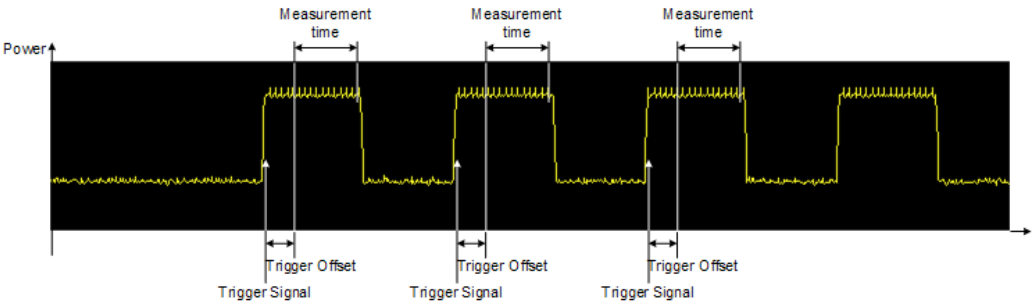
```
// Configures the status reporting system to produce a service request.
LIST:POW:SET ON,ON,OFF,EXT,POS,10us,434us
//Turns on the list evaluation, configures the global list evaluation settings and
//evaluates the peak and RMS power.
LIST:POW
935.2MHZ,0,10,OFF,NORM,1MHZ,3MHZ,440us,0,
935.4MHZ,0,10,10,CFIL,30KHZ,100KHZ,440us,0,
935.6MHZ,0,10,20,CFIL,30KHZ,100KHZ,440us,0;
*OPC
//Defines a list with 3 entries and initiates the measurement with synchronization to the end
//Analyzer produces a service request
//On service request:
SENS:LIST:POW:RES?
//Returns the results of the measurements, two for each frequency (peak and RMS power).

-----Initiliazing the measurement and querying results simultaneously-----
LIST:POW?
935.2MHZ,0,10,OFF,NORM,1MHZ,3MHZ,440us,0,
935.4MHZ,0,10,10,CFIL,30KHZ,100KHZ,440us,0,
935.6MHZ,0,10,20,CFIL,30KHZ,100KHZ,440us,0
//Defines a list with 3 entries, initiates the measurement and queries the results.
//Result example:
-28.3,-30.6,-38.1
```

5.2.15 Measuring the Pulse Power

All remote control commands specific to measuring the mean or peak pulse power (e.g. bursts in various telecommunications standards) are described here. This measurement is available via remote control only.

The Pulse Power measurement is a gated measurement that determines the power over a particular number of pulses. The measurement is controlled by an external trigger or the video signal. A separate trigger event is required for each burst included in the measurement. In case of an external trigger source, the trigger level corresponds to the TTL level. In case of a video signal, you can define any threshold.

The figure below shows the relations between the available trigger settings.



The measurement is always on trace 1, either with the peak detector to determine the peak power or the RMS detector to determine the RMS power. Overall, you can config-

ure the measurement independent of the instrument setup with the commands listed below only, which results in faster measurements.

The Pulse Power measurement is incompatible to other measurement functions (e.g. marker functionality or statistics). If you use a command that controls those functions, the R&S FSWP aborts the Pulse Power measurement.

The R&S FSWP also aborts the Pulse Power measurement if you end the remote session.

The commands can be used in two different ways.

- Instrument setup, measurement and querying of the results in a single command line. With this method, there is the least delay between the measurement and the result output. However, it requires the control computer to wait for the response from the instrument.
- Instrument setup and querying of the result list at the end of the measurement: With this method, the control computer may be used for other activities while the measurement is being performed. However, more time is needed for synchronization via service request.

5.2.15.1 Performing Pulse Power Measurements

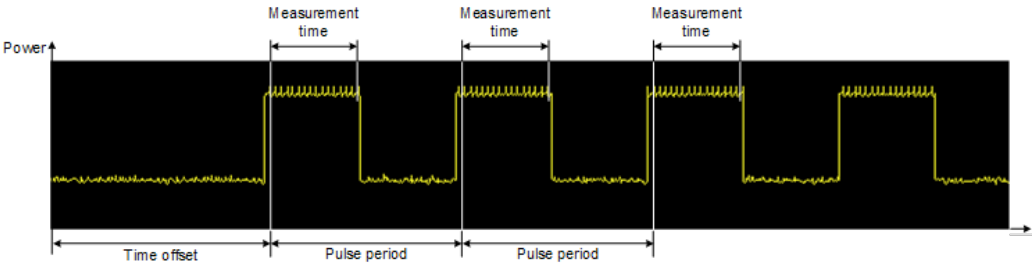
The following commands control pulse power measurements.

CALCulate<n>:MARKer<m>:FUNCtion:MSUMmary 526
[SENSe:]MPOWer:FTYPe 527
[SENSe:]MPOWer:RESult[:LIST]? 527
[SENSe:]MPOWer:[:SEQuence] 528
[SENSe:]MPOWer:RESult:MIN? 529

CALCulate<n>:MARKer<m>:FUNCtion:MSUMmary
<TimeOffset>,<MeasTime>,<PulsePeriod>,<#OfPulses>

This command configures power measurements on pulses in the time domain.

To evaluate the pulse power, the R&S FSWP uses the data captured during a previous measurement. The data recorded during the set measurement time is combined to a measured value for each pulse according to the detector specified and the indicated number of results is output as a list.



To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Parameters:

<TimeOffset> Defines a time offset to start the measurement at the first pulse of a trace.

*RST: 0
Default unit: s

<MeasTime> Defines the measurement time.

Default unit: s

<PulsePeriod> Defines the pulse period

<#OfPulses> Defines the number of pulses to measure.

Example: `CALC:MARK:FUNC:MSUM 50US,450US,576.9US,8`
Evaluates data that contains 8 pulses during a measurement time of 450 µs and a pulse period of 576.9 µs. The evaluation starts with an offset of 50 µs.

[SENSe:]MPOWer:FTYPe <FilterType>

This command selects the filter type for pulse power measurements.

Parameters:

<FilterType>

CFILter
Channel filters
Available in the Spectrum application.

NORMal
3 dB Gaussian filters
Available in the Spectrum application.

P5
5-pole filters
Available for FFT sweeps in the Spectrum application.

RRC
RRC filters

*RST: Depends on application

[SENSe:]MPOWer:RESult[:LIST]?

This command queries the results of the pulse power measurement.

This command may be used to obtain measurement results in an asynchronous way, using the service request mechanism for synchronization to the end of the measurement.

If there are no results, the command returns an error.

Return values:

<PulsePower> List of pulse powers.
The number of values depends on the number of pulses you have been measuring.
The unit is dBm.

Usage: Query only

[SENSe:]MPOWer:[:SEQuence] <Frequency>, <RBW>, <MeasTime>, <TriggerSource>, <TriggerLevel>, <TriggerOffset>, <Detector>, <#OfPulses>

This command configures and initiates the pulse power measurement.

The R&S FSWP caches all measurement parameters that you can set with this command. If you use the command repeatedly, the R&S FSWP only changes those settings that you have actually changed before initiating the measurement. Thus, measurement times are kept as low as possible.

If you synchronize the measurement with `*OPC`, the R&S FSWP produces a service request when all frequencies have been measured and the number of individual measurements has been performed.

Note that using the command as a query initiates the measurement and returns the results if all frequencies have been measured. For more information on querying the results see `[SENSe:]LIST:POWer:RESult?`.

Parameters:

<Frequency> Defines the pulse frequency.

Range: 0 to Fmax
Default unit: Hz

<RBW> Defines the resolution bandwidth.

<MeasTime> Defines the measurement time.

Range: 1 µs to 30 s

<TriggerSource> Selects a trigger source.

<TriggerLevel> Defines a trigger level.
The trigger level is available for the video trigger. In that case, the level is a percentage of the diagram height.
In case of an external trigger, the R&S FSWP uses a fix TTL level.

Range: 0 to 100
Default unit: PCT

<TriggerOffset> Defines the trigger delay.

Range: 0 s to 30 s
*RST: 0 s
Default unit: s

<Detector> Selects the detector and therefore the way the measurement is evaluated.

MEAN
Calculates the RMS pulse power.

PEAK
Calculates the peak pulse power.

<#OfPulses> Defines the number of pulses included in the measurement.

Range: 1 to 32001

Return values:

<PowerLevel> Pulse power level.
The result is a list of floating point values separated by commas.
The unit is dBm.

[SENSe:]MPOWer:RESult:MIN?

This command queries the lowest pulse power that has been measured during a pulse power measurement.

If there are no results, the command returns an error.

Return values:

<PulsePower> Lowest power level of the pulse power measurement.
The unit is dBm.

Usage: Query only

5.2.15.2 Example: Performing a Pulse Power Measurement

The following example shows a pulse power measurement.

```
-----Measurement with synchronization via service request-----
*ESE 1
*SRE 32
// Configures the status reporting system to produce a service request.
MPOW:FTYP NORM
//Selects a Gaussian filter for the measurement.
MPOW 935.2MHZ,1MHZ,434us,VID,50,5us,MEAN,20;
*OPC
//Configures and initiates a measurement on 20 pulses with synchronization to the end.
//Analyzer produces a service request
//On service request:
MPOW:RES?
//Returns the results of the measurements (20 power levels).
MPOW:RES:MIN?
//Returns the lowest of the 20 power level that have been measured.

-----Initiliazing the measurement and querying results simultaneously-----
MPOW? 935.2MHZ,1MHZ,434us,VID,50,5us,MEAN,20
//Configures, initiates and queries the results of the measurement.
```

```
//Result example:
-105.225059509,-105.656074524,-105.423065186,-104.374649048,-103.059822083,-101.29511261,
-99.96534729,-99.7452468872,-99.6610794067,-100.327224731,-100.96686554,-101.450386047,
-102.150642395,-103.240142822,-105.95476532,-110.583129883,-115.7760849,-126.279388428,
-124.620399475,-116.97366333
```

5.2.16 Programming Example: Performing a Basic Frequency Sweep

This example demonstrates how to configure and perform a basic frequency sweep measurement in a remote environment.

```
//--------------Preparing the measurement ---------------------
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.

//--------------Configuring the Frequency and Span-------------
FREQ:CENT 100MHz
//Defines the center frequency
FREQ:SPAN 200MHz
//Sets the span to 100 MHz on either side of the center frequency.

//Activate signal tracking to keep the center frequency on the signal peak:
CALC:MARK:FUNC:STR ON
CALC:MARK:FUNC:STR:BAND 20MHz
CALC:MARK:FUNC:STR:THR -90dBm
CALC:MARK:FUNC:STR:TRAC 1
//After each sweep the maximum on trace 1 is searched within a range of 20 MHz
//around the center frequency. It must have a minimum power of -90dBm.

//--------------Configuring the Bandwidth----------------------
BAND:AUTO OFF
BAND 1MHz
BAND:TYPE RRC
//Defines the RBW as 1 MHz using an RRC filter

BAND:VID:AUTO OFF
BAND:VID 500kHz
//Decouples the VBW from the RBW and decreases it to smooth the trace.

//--------------Configuring the Sweep--------------------------
SENS:SWE:COUN 10
//Defines 10 sweeps to be performed in each measurement.
SENS:SWE:POIN 500
//During each sweep, 500 trace points will be measured.
SENS:SWE:TIME:AUTO OFF
SENS:SWE:TIME 50ms
//Decouples the sweep time from the RBW,VBW and span and increases it to
```

```
//make the measurement more precise.

//--------------Configuring Attenuation------------------------
//Only if electronic attenuator is available:
//INP:EATT:STAT ON
//Switches on the electronic attenuator.
//INP:EATT 30dB
//Sets the electronic attenuation to 30 dB.
INP:ATT 10dB
//Sets the mechanical attenuation to 10 dB and couples the reference level
//to the attenuation instead of vice versa.

//--------------Configuring the Amplitude and Scaling----------
DISP:TRAC1:Y:RLEV -10dBm
//Sets the reference level to -10 dBm.
DISP:TRAC1:Y:RLEV:OFFS 10dB
//Shifts the trace display in the diagram up by 10dB.
CALC:UNIT:POW V
//Sets the unit of the y-axis to Volt. The reference level is now 70.711 mV.
DISP:TRAC1:Y:SPAC LOG
//Uses logarithmic scaling with absolute values (V).
DISP:TRAC1:Y 110dB
//Increases the displayed range of the y-axis to 110 dB.
DISP:TRAC1:Y:RPOS 80PCT
//Shifts the display of the reference level down, it is no longer the top line
//in the diagram. The reference level is displayed as a red line.

//--------------Triggering-------------------------------------
TRIG:SOUR IFP
TRIG:LEV:IFP -10dBm
TRIG:SLOP POS
TRIG:DTIM 50ms
TRIG:IFP:HYST 5dB
TRIG:HOLD 10ms
//Defines triggering when the second intermediate frequency rises to a level
//of -10 dBm, with a dropout time of 50 ms, a hysteresis of 5 dB and a delay
//of 10 ms.


SWE:EGAT ON
SWE:EGAT:TYPE EDGE
SWE:EGAT:LENG 5ms
//Defines gating. Values are measured for 5 ms after triggering.

OUTP:TRIG2:DIR OUTP
OUTP:TRIG2:OTYP UDEF
OUTP:TRIG2:LEV HIGH
OUTP:TRIG2:PULS:LENG 100us
OUTP:TRIG2:PULS:IMM
//Configures a high trigger signal with a pulse length of 100 us to be output at
```

```
//the front TRIGGER INPUT/OUTPUT connector once.

//--------------Configuring the Trace--------------------------
DISP:TRAC2 ON
DISP:TRAC2:MODE AVER
DISP:TRAC3 ON
DISP:TRAC3:MODE MAXH
//Configures 3 traces: 1 (default): clear/write; 2: average; 3: max hold

SENS:DET1 POS
SENS:DET2 RMS
SENS:DET3 POS
//Configures traces 1 and 3 to use the positive peak detector; trace 2 uses
//the RMS detector.

TRAC:COPY TRACE4,TRACE1
//Copies trace 1 to a new trace 4 which will then be averaged.

SENS:AVER:STAT4 ON
SENS:AVER:COUN 10
SENS:AVER:TYPE LIN
//Configures trace 4 to be averaged linearly over 10 sweeps.

CALC:MATH:STAT ON
CALC:MATH:MODE LIN
CALC:MATH (TRACE1-TRACE2)
CALC:MATH:POS 100
//Calculates the linear difference between the measured and average values.
//The resulting trace is displayed at the top of the diagram.

//--------------Performing the Measurement---------------------
INIT;*WAI
//Initiates a new measurement and waits until the last sweep has finished.

//---------------Retrieving Results-----------------------------
TRAC:DATA? TRACE1
TRAC:DATA? TRACE2
TRAC:DATA? TRACE3
TRAC:DATA? TRACE4
//Returns one power and one frequency value per sweep point for each trace.
```

5.3 Remote Commands to Select the Spectrum Application

INSTrument:CREate:DUPLicate 533
INSTrument:CREate[:NEW] 533
INSTrument:CREate:REPLace 533

INSTrument:DELete....534
INSTrument:LIST?....534
INSTrument:REName....535
INSTrument[:SELect]....535

INSTrument:CREate:DUPLicate

This command duplicates the currently selected measurement channel, i.e creates a new measurement channel of the same type and with the identical measurement settings. The name of the new channel is the same as the copied channel, extended by a consecutive number (e.g. "IQAnalyzer" -> "IQAnalyzer2").

The channel to be duplicated must be selected first using the `INST:SEL` command.

This command is not available if the MSRA Master channel is selected.

Example:
```
INST:SEL 'PhaseNoise'
INST:CRE:DUPL
```
Duplicates the channel named 'PhaseNoise' and creates a new measurement channel named 'PhaseNoise 2'.

Usage: Event

INSTrument:CREate[:NEW] <ChannelType>, <ChannelName>

This command adds an additional measurement channel.

The number of measurement channels you can configure at the same time depends on available memory.

See also

- `INSTrument[:SELect]` on page 535
- `INSTrument:CREate:DUPLicate` on page 533

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 534.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 534).

Example:
```
INST:CRE PNO, 'PhaseNoise 2'
```
Adds an additional phase noise display named "PhaseNoise 2".

INSTrument:CREate:REPLace <ChannelName1>,<ChannelType>,<ChannelName2>

This command replaces a measurement channel with another one.

Setting parameters:

<ChannelName1> String containing the name of the measurement channel you want to replace.

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 534.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 534).

Example: `INST:CRE:REPL 'PhaseNoise',PNO,'PNO2'`
Replaces the channel named 'PhaseNoise' by a new measurement channel of type 'Phase Noise' named 'PNO2'.

Usage: Setting only

INSTrument:DELete <ChannelName>

This command deletes a measurement channel.

If you delete the last measurement channel, the default "Phase Noise" channel is activated.

Parameters:

<ChannelName> String containing the name of the channel you want to delete.
A measurement channel must exist in order to be able delete it.

Example: `INST:DEL 'PhaseNoise'`
Deletes the channel with the name 'PhaseNoise'.

Usage: Event

INSTrument:LIST?

This command queries all active measurement channels. This is useful in order to obtain the names of the existing measurement channels, which are required in order to replace or delete the channels.

Return values:

<ChannelType>, <ChannelName> For each channel, the command returns the channel type and channel name (see tables below).
Tip: to change the channel name, use the `INSTrument:REName` command.

Example: `INST:LIST?`
Result for 2 measurement channels:
`'PNO','PhaseNoise','PNO','PhaseNoise2'`

Usage: Query only

Table 5-1: Available measurement channel types and default channel names

Application	<ChannelType> Parameter	Default Channel Name*)
Phase Noise	PNOISE	Phase Noise
Spectrum (R&S FSWP-B1)	SANALYZER	Spectrum
I/Q Analyzer (R&S FSWP-B1)	IQ	IQ Analyzer
Analog Demodulation (R&S FSWP-K7)	ADEM	Analog Demod
Noise Figure Measurements (R&S FSWP-K30)	NOISE	Noise
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

<ChannelName1> String containing the name of the channel you want to rename.

<ChannelName2> String containing the new channel name.
Note that you can not assign an existing channel name to a new channel; this will cause an error.

Example: `INST:REN 'PhaseNoise','PNO'`
Renames the channel with the name PhaseNoise' to 'PNO'.

Usage: Setting only

INSTrument[:SELect] <ChannelType> | <ChannelName>

This command activates a new measurement channel with the defined channel type, or selects an existing measurement channel with the specified name.

Also see

- `INSTrument:CREate[:NEW]` on page 533

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 534.

<ChannelName> String containing the name of the channel.

Example: `INST IQ`
Activates a measurement channel for the I/Q Analyzer application (evaluation mode).
`INST 'MyIQSpectrum'`
Selects the measurement channel named 'MyIQSpectrum' (for example before executing further commands for that channel).

Usage: SCPI confirmed

5.4 General Window Commands

The following commands are required to configure general window layout, independent of the application.

Note that the suffix <n> always refers to the window *in the currently selected measurement channel* (see `INSTrument[:SELect]` on page 535).

DISPlay:FORMat 536
DISPlay[:WINDow<n>]:SELect 536
DISPlay[:WINDow<n>]:SIZE 536
DISPlay:WSELect? 537

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format>

SPLit
Displays the MultiView tab with an overview of all active channels
(See chapter 1.1, "R&S MultiView", on page 11).

SINGle
Displays the measurement channel that was previously focused.

*RST: SING

Example: `DISP:FORM SPL`

DISPlay[:WINDow<n>]:SELect

This command sets the focus on the selected result display window.

This window is then the active window.

Example: `DISP:WIND1:SEL`
Sets the window 1 active.

Usage: Setting only

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 540).

Parameters:

<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example: `DISP:WIND2:LARG`

DISPlay:WSELect?

This command queries the currently active window (the one that is focused) *in the currently selected measurement channel*.

Return values:

<ActiveWindow> Index number of the currently active window.

Range: 1 to 16

Usage: Query only

5.5 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

Note that the suffix <n> always refers to the window *in the currently selected measurement channel* (see `INSTrument[:SELect]` on page 535).

LAYout:ADD[:WINDow]?....537
LAYout:CATalog[:WINDow]?....538
LAYout:IDENtify[:WINDow]?....539
LAYout:REMove[:WINDow]....539
LAYout:REPLace[:WINDow]....540
LAYout:SPLitter....540
LAYout:WINDow<n>:ADD?....542
LAYout:WINDow<n>:IDENtify?....542
LAYout:WINDow<n>:REMove....542
LAYout:WINDow<n>:REPLace....543

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display in the active measurement channel.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow
Direction the new window is added relative to the existing window.

<WindowType> text value
Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:
```
LAY:ADD? '1',LEFT,MTAB
```
Result:
```
'2'
```
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual operation: See "Diagram" on page 302
See "Marker Table" on page 302
See "Marker Peak List" on page 303
See "Result Summary" on page 303
See "Spectrogram" on page 303

Table 5-2: <WindowType> parameter values for the Spectrum application

Parameter value	Window type
DIAGram	Diagram
MTABle	Marker table
PEAKlist	Marker peak list
RSUMmary	Result summary
SGRam	Spectrogram

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows in the active measurement channel from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string
Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window in the active measurement channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Example: `LAY:WIND:IDEN? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display in the active measurement channel.

Parameters:

<WindowName> String containing the name of the window.
In the default state, the name of the window is its index.

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active measurement channel while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active measurement channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 537 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 536 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

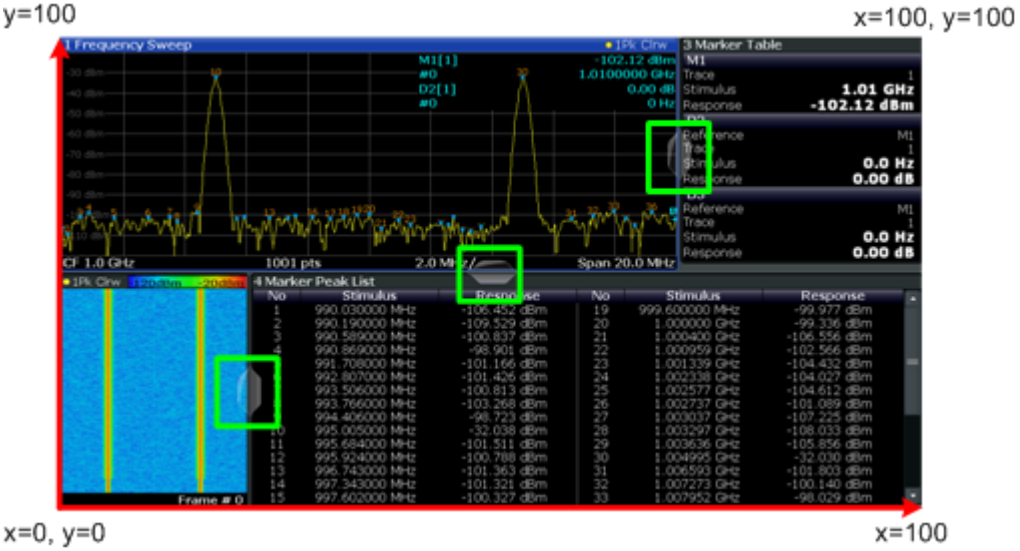


Fig. 5-1: SmartGrid coordinates for remote control of the splitters

Parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See figure 5-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.

Range: 0 to 100

Example: `LAY:SPL 1,3,50`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: `LAY:SPL 1,4,70`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.

```
LAY:SPL 3,2,70
LAY:SPL 4,1,70
LAY:SPL 2,1,70
```

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added, as opposed to `LAYout:ADD[:WINDow]?`, for which the existing window is defined by a parameter.

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

Parameters:

<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 537 for a list of available window types.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:
```
LAY:WIND1:ADD? LEFT,MTAB
```
Result:
```
'2'
```
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix) in the active measurement channel.

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Return values:

<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Example:
```
LAY:WIND2:IDEN?
```
Queries the name of the result display in window 2.
Response:
```
'2'
```

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display in the active measurement channel.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Example: `LAY:WIND2:REM`
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>) in the active measurement channel.

The result of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Parameters:

<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 537 for a list of available window types.

Example: `LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

5.6 Preset

SYSTem:PRESet 543
SYSTem:PRESet:CHANnel[:EXECute] 543

SYSTem:PRESet

This command presets the R&S FSWP.

Example: `SYST:PRES`

Usage: Event
SCPI confirmed

SYSTem:PRESet:CHANnel[:EXECute]

This command restores the default instrument settings in the current channel.

Use `INST:SEL` to select the channel.

Example: `INST 'Spectrum2'`
Selects the channel for "Spectrum2".
`SYST:PRES:CHAN:EXEC`
Restores the factory default settings to the "Spectrum2" channel.

Usage: Event

Manual operation: See "Preset Channel" on page 194

5.7 Common Measurement Settings

- Configuring Inputs and Ouputs 544
- Defining the Frequency 569
- Amplitude Settings 575
- Scaling the Y-Axis 578
- Remote Commands to Define Filter Characteristics 580
- Remote Commands to Control a Measurement 583
- Trigger Configuration 589
- Automatic Configuration 596
- Transducer 599

5.7.1 Configuring Inputs and Ouputs

- Selecting the Input Source 544
- Configuring the RF Input 544
- Configuring Power Sensors 547
- Configuring External Generators 558
- Configuring General Outputs 565
- Programming Example for External Generator Control 569

5.7.1.1 Selecting the Input Source

INPut:SELect 544

INPut:SELect <Source>

This command selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S FSWP.

Parameters:

<Source> **RF**
Radio Frequency ("RF INPUT" connector)
*RST: RF

Manual operation: See "Radio Frequency State" on page 197

5.7.1.2 Configuring the RF Input

INPut:ATTenuation:PROTection:RESet 545
INPut:COUPling 545
INPut:DPATh 545
INPut:FILTer:HPASs[:STATe] 546
INPut:FILTer:YIG[:STATe] 546

INPut:IMPedance....546
INPut:UPORt[:VALue]?....547
INPut:UPORt:STATe....547

INPut:ATTenuation:PROTection:RESet

This command resets the attenuator and reconnects the RF input with the input mixer after an overload condition occured and the protection mechanism intervened.The error status bit (bit 3 in the `STAT:QUES:POW` status register) and the `INPUT OVLD` message in the status bar are cleared.

(See the description of the `STATus:QUEStionable:POWer` status register in the R&S FSWP manual.

The command works only if the overload condition has been eliminated first.

For details on the protection mechanism see chapter 3.2.1.1, "RF Input Protection", on page 195.

Usage: Event

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

<CouplingType>
AC
AC coupling
DC
DC coupling
*RST: AC

Example: `INP:COUP DC`

Usage: SCPI confirmed

Manual operation: See "Input Coupling" on page 197

INPut:DPATh <State>

Enables or disables the use of the direct path for frequencies close to 0 Hz.

Parameters:

<State>
AUTO | 1
(Default) the direct path is used automatically for frequencies close to 0 Hz.
OFF | 0
The analog mixer path is always used.
*RST: 1

Example: `INP:DPAT OFF`

Usage: SCPI confirmed

INPut:FILTer:HPASs[:STATe] <State>

Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the R&S FSWP in order to measure the harmonics for a DUT, for example.

This function requires an additional high-pass filter hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG filter.)

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:FILT:HPAS ON`
Turns on the filter.

Usage: SCPI confirmed

Manual operation: See "High-Pass Filter 1...3 GHz" on page 198

INPut:FILTer:YIG[:STATe] <State>

This command turns the YIG-preselector on and off.

Note the special conditions and restrictions for the YIG filter described in "YIG-Preselector" on page 198.

Parameters:

<State> ON | OFF | 0 | 1

*RST: OFF

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See "YIG-Preselector" on page 198

INPut:IMPedance <Impedance>

This command selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a matching pad of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The power loss correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Parameters:

<Impedance> 50 | 75

*RST: 50 Ω

Example: `INP:IMP 75`

Usage: SCPI confirmed

Manual operation: See "Impedance" on page 197
See "Unit" on page 251

INPut:UPORt[:VALue]?

This command queries the control lines of the user ports.

For details see `OUTPut:UPORt[:VALue]` on page 568.

Return values:

<Value> bit values in hexadecimal format
TTL type voltage levels (max. 5V)
Range: #B00000000 to #B00111111

Example:
```
INP:UPOR?
//Result: #B00100100
```
Pins 5 and 7 are active.

Usage: Query only

INPut:UPORt:STATe <State>

This command toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S FSWP.

See the R&S FSWP Getting Started manual for details.

Parameters:

<State>
ON | 1
User port is switched to INPut
OFF | 0
User port is switched to OUTPut
*RST: 1

5.7.1.3 Configuring Power Sensors

CALibration:PMETer<p>:ZERO:AUTO ONCE 548
CALCulate<n>:PMETer<p>:RELative:STATe 548
CALCulate<n>:PMETer<p>:RELative[:MAGNitude] 549
CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE 549
FETCh:PMETer<p>? 549
READ:PMETer<p>? 550
[SENSe:]PMETer<p>[:STATe] 550
[SENSe:]PMETer<p>:DCYCle[:STATe] 550
[SENSe:]PMETer<p>:DCYCle:VALue 550
[SENSe:]PMETer<p>:FREQuency 551
[SENSe:]PMETer<p>:FREQuency:LINK 551
[SENSe:]PMETer<p>:MTIMe 552
[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt 552

[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe] 552
[SENSe:]PMETer<p>:ROFFset[:STATe] 553
[SENSe:]PMETer<p>:TRIGger:DTIMe 553
[SENSe:]PMETer<p>:TRIGger:HOLDoff 553
[SENSe:]PMETer<p>:TRIGger:HYSTeresis 554
[SENSe:]PMETer<p>:TRIGger:LEVel 554
[SENSe:]PMETer<p>:TRIGger:SLOPe 555
[SENSe:]PMETer<p>:TRIGger[:STATe] 555
[SENSe:]PMETer<p>:UPDate[:STATe] 555
SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe] 556
SYSTem:COMMunicate:RDEVice:PMETer:COUNt? 556
SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine 556
UNIT<n>:PMETer<p>:POWer 557
UNIT<n>:PMETer<p>:POWer:RATio 557

CALibration:PMETer<p>:ZERO:AUTO ONCE

This commands starts to zero the power sensor.

Note that you have to disconnect the signals from the power sensor input before you start to zero the power sensor. Otherwise, results are invalid.

Suffix:
<p> 1...4
Power sensor index

Parameters:
ONCE

Example: `CAL:PMET2:ZERO:AUTO ONCE;*WAI`
Starts zeroing the power sensor 2 and delays the execution of further commands until zeroing is concluded.

Usage: Event

Manual operation: See "Zeroing Power Sensor" on page 202

CALCulate<n>:PMETer<p>:RELative:STATe <State>

This command turns relative power sensor measurements on and off.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:PMET2:REL:STAT ON`
Activates the relative display of the measured value for power sensor 2.

CALCulate<n>:PMETer<p>:RELative[:MAGNitude] <RefValue>

This command defines the reference value for relative measurements.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<RefValue> Range: -200 dBm to 200 dBm
*RST: 0

Example: `CALC:PMET2:REL -30`
Sets the reference value for relative measurements to -30 dBm for power sensor 2.

Manual operation: See "Reference Value" on page 203

CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE

This command sets the current measurement result as the reference level for relative measurements.

Suffix:
<p> 1...4
Power sensor index

Parameters:
ONCE

Example: `CALC:PMET2:REL:AUTO ONCE`
Takes the current measurement value as reference value for relative measurements for power sensor 2.

Usage: Event

Manual operation: See "Setting the Reference Level from the Measurement (Meas->Ref)" on page 203

FETCh:PMETer<p>?

This command queries the results of power sensor measurements.

Suffix:
<p> 1...4
Power sensor index

Return values:
<Level> Power level that has been measured by a power sensor.
The unit is either dBm (absolute measurements) or dB (relative measurements).

Usage: Query only

READ:PMETer<p>?

This command initiates a power sensor measurement and queries the results.

Suffix:
<p> 1...4
Power sensor index

Usage: Query only

[SENSe:]PMETer<p>[:STATe] <State>

This command turns a power sensor on and off.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<State> ON | OFF
*RST: OFF

Example: `PMET1 ON`
Switches the power sensor measurements on.

Manual operation: See "State" on page 201
See "Select" on page 202

[SENSe:]PMETer<p>:DCYCle[:STATe] <State>

This command turns the duty cycle correction on and off.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<State> ON | OFF
*RST: OFF

Example: `PMET2:DCYC:STAT ON`

Manual operation: See "Duty Cycle" on page 204

[SENSe:]PMETer<p>:DCYCle:VALue <Percentage>

This command defines the duty cycle for the correction of pulse signals.

The power sensor uses the duty cycle in combination with the mean power to calculate the power of the pulse.

Suffix:
<p> 1...4
Power sensor

Parameters:

<Percentage> Range: 0.001 to 99.999
*RST: 99.999
Default unit: %

Example: `PMET2:DCYC:STAT ON`
Activates the duty cycle correction.
`PMET2:DCYC:VAL 0.5`
Sets the correction value to 0.5%.

Manual operation: See "Duty Cycle" on page 204

[SENSe:]PMETer<p>:FREQuency <Frequency>

This command defines the frequency of the power sensor.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Frequency> The available value range is specified in the data sheet of the power sensor in use.
*RST: 50 MHz

Example: `PMET2:FREQ 1GHZ`
Sets the frequency of the power sensor to 1 GHz.

Manual operation: See "Frequency Manual" on page 202

[SENSe:]PMETer<p>:FREQuency:LINK <Coupling>

This command selects the frequency coupling for power sensor measurements.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Coupling> **CENTer**
Couples the frequency to the center frequency of the analyzer
MARKer1
Couples the frequency to the position of marker 1
OFF
Switches the frequency coupling off
*RST: CENTer

Example: `PMET2:FREQ:LINK CENT`
Couples the frequency to the center frequency of the analyzer

Manual operation: See "Frequency Coupling" on page 203

[SENSe:]PMETer<p>:MTIMe <Duration>

This command selects the duration of power sensor measurements.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<Duration> SHORt | NORMal | LONG
*RST: NORMal

Example: `PMET2:MTIM SHOR`
Sets a short measurement duration for measurements of stationary high power signals for the selected power sensor.

Manual operation: See "Meas Time/Average" on page 203

[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt <NumberReadings>

This command sets the number of power readings included in the averaging process of power sensor measurements.

Extended averaging yields more stable results for power sensor measurements, especially for measurements on signals with a low power, because it minimizes the effects of noise.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<NumberReadings> An average count of 0 or 1 performs one power reading.
Range: 0 to 256
Increment: binary steps (1, 2, 4, 8, ...)

Example: `PMET2:MTIM:AVER ON`
Activates manual averaging.
`PMET2:MTIM:AVER:COUN 8`
Sets the number of readings to 8.

Manual operation: See "Average Count (Number of Readings)" on page 204

[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe] <State>

This command turns averaging for power sensor measurements on and off.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<State> ON | OFF
*RST: OFF

Example: `PMET2:MTIM:AVER ON`
Activates manual averaging.

Manual operation: See "Meas Time/Average" on page 203

[SENSe:]PMETer<p>:ROFFset[:STATe] <State>

This command includes or excludes the reference level offset of the analyzer for power sensor measurements.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<State> **ON | 1**
Includes the reference level offset in the results.

OFF | 0
Ignores the reference level offset.

*RST: 1

Example: `PMET2:ROFF OFF`
Takes no offset into account for the measured power.

Manual operation: See "Use Ref Lev Offset" on page 204

[SENSe:]PMETer<p>:TRIGger:DTIMe <Time>

This command defines the time period that the input signal has to stay below the IF power trigger level before the measurement starts.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<Time> Range: 0 s to 1 s
Increment: 100 ns
*RST: 100 µs

Example: `PMET2:TRIG:DTIMe 0.001`

[SENSe:]PMETer<p>:TRIGger:HOLDoff <Holdoff>

This command defines the trigger holdoff for external power triggers.

Suffix:
<p> 1...4
Power sensor index

Parameters:

<Holdoff> Time period that has to pass between the trigger event and the start of the measurement, in case another trigger event occurs.

Range: 0 s to 1 s
Increment: 100 ns
*RST: 0 s

Example: `PMET2:TRIG:HOLD 0.1`
Sets the holdoff time of the trigger to 100 ms

Manual operation: See "Trigger Holdoff" on page 205

[SENSe:]PMETer<p>:TRIGger:HYSTeresis <Hysteresis>

This command defines the trigger hysteresis for external power triggers.

The hysteresis in dB is the value the input signal must stay below the IF power trigger level in order to allow a trigger to start the measurement.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Hysteresis> Range: 3 dB to 50 dB
Increment: 1 dB
*RST: 0 dB

Example: `PMET2:TRIG:HYST 10`
Sets the hysteresis of the trigger to 10 dB.

Manual operation: See "Hysteresis" on page 205

[SENSe:]PMETer<p>:TRIGger:LEVel <Level>

This command defines the trigger level for external power triggers.

This command requires the use of an R&S NRP-Z81 power sensor.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Level> -20 to +20 dBm

Range: -20 dBm to 20 dBm
*RST: -10 dBm

Example: `PMET2:TRIG:LEV -10 dBm`
Sets the level of the trigger

Manual operation: See "External Trigger Level" on page 204

[SENSe:]PMETer<p>:TRIGger:SLOPe <Edge>

This command selects the trigger condition for external power triggers.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<Edge> **POSitive**
The measurement starts in case the trigger signal shows a positive edge.

NEGative
The measurement starts in case the trigger signal shows a negative edge.

*RST: POSitive

Example: `PMET2:TRIG:SLOP NEG`

Manual operation: See "Slope" on page 205

[SENSe:]PMETer<p>:TRIGger[:STATe] <State>

This command turns the external power trigger on and off.

This command requires the use of an R&S NRP-Z81 power sensor.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<State> ON | OFF

*RST: OFF

Example: `PMET2:TRIG ON`
Switches the external power trigger on

Manual operation: See "Using the power sensor as an external trigger" on page 204

[SENSe:]PMETer<p>:UPDate[:STATe] <State>

This command turns continuous update of power sensor measurements on and off.

If on, the results are update even if a single sweep is complete.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<State> ON | OFF

*RST: OFF

Example: `PMET1:UPD ON`
The data from power sensor 1 is updated continuously.

Manual operation: See "Continuous Value Update" on page 202

SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe] <State>

This command turns automatic assignment of a power sensor to the power sensor index on and off.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `SYST:COMM:RDEV:PMET:CONF:AUTO OFF`

Manual operation: See "Select" on page 202

SYSTem:COMMunicate:RDEVice:PMETer:COUNt?

This command queries the number of power sensors currently connected to the R&S FSWP.

Parameters:
<NumberSensors> Number of connected power sensors.

Example: `SYST:COMM:RDEV:PMET:COUN?`

Usage: Query only

Manual operation: See "Select" on page 202

SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine <Placeholder>, <Type>, <Interface>, <SerialNo>

This command assigns the power sensor with the specified serial number to the selected power sensor index (configuration).

The query returns the power sensor type and serial number of the sensor assigned to the specified index.

Suffix:
<p> 1...4
Power sensor index

Setting parameters:
<Placeholder> Currently not evaluated

<SerialNo> Serial number of a connected power sensor

Query parameters:

<Type> The power sensor type, e.g. "NRP-Z81".

<Interface> Currently not evaluated

Return values:

<Placeholder> Currently not used

<Type> Detected power sensor type, e.g. "NRP-Z81".

<Interface> Interface the power sensor is connected to; always "USB"

<SerialNo> Serial number of the power sensor assigned to the specified index

Example:
```
SYST:COMM:RDEV:PMET2:DEF '','NRP-Z81','',
'123456'
```
Assigns the power sensor with the serial number '123456' to the configuration "Power Sensor 2".
```
SYST:COMM:RDEV:PMET2:DEF?
```
Queries the sensor assigned to "Power Sensor 2".
Result:
```
'','NRP-Z81','USB','123456'
```
The NRP-Z81 power sensor with the serial number '123456' is assigned to the "Power Sensor 2".

Manual operation: See "Select" on page 202

UNIT<n>:PMETer<p>:POWer <Unit>

This command selects the unit for absolute power sensor measurements (<n> is irrelevant).

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Unit> DBM | WATT | W

*RST: DBM

Example:
```
UNIT:PMET:POW DBM
```

Manual operation: See "Unit/Scale" on page 203

UNIT<n>:PMETer<p>:POWer:RATio <Unit>

This command selects the unit for relative power sensor measurements (<n> is irrelevant).

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Unit> DB | PCT

*RST: DB

Example: `UNIT:PMET:POW:RAT DB`

Manual operation: See "Unit/Scale" on page 203

5.7.1.4 Configuring External Generators

Commands to configure external generators described elsewhere:

- `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue` on page 579

[SENSe:]CORRection:COLLect[:ACQuire] 558
[SENSe:]CORRection:METHod 559
[SENSe:]CORRection:RECall 559
[SENSe:]CORRection[:STATe] 560
[SENSe:]CORRection:TRANsducer:GENerator 560
SOURce:EXTernal:FREQuency 560
SOURce:EXTernal:FREQuency:COUPling[:STATe] 561
SOURce:EXTernal:FREQuency[:FACTor]:DENominator 561
SOURce:EXTernal:FREQuency[:FACTor]:NUMerator 562
SOURce:EXTernal:FREQuency:OFFSet 562
SOURce:EXTernal:FREQuency:SWEep[:STATe] 562
SOURce:EXTernal:POWer[:LEVel] 563
SOURce:EXTernal[:STATe] 563
SOURce:POWer[:LEVel][:IMMediate]:OFFSet 563
SOURce:EXTernal:ROSCillator[:SOURce] 563
SYSTem:COMMunicate:GPIB:RDEVice:GENerator:ADDRess 564
SYSTem:COMMunicate:RDEVice:GENerator:INTerface 564
SYSTem:COMMunicate:RDEVice:GENerator:LINK 564
SYSTem:COMMunicate:RDEVice:GENerator:TYPE 565
SYSTem:COMMunicate:TCPip:RDEVice:GENerator:ADDRess 565

[SENSe:]CORRection:COLLect[:ACQuire] <MeasType>

This command initiates a reference measurement (calibration). The reference measurement is the basis for the measurement normalization. The result depends on whether a reflection measurement or transmission measurement is performed (see `[SENSe:]CORRection:METHod` on page 559).

To obtain a correct reference measurement, a complete sweep with synchronization to the end of the sweep must have been carried out. This is only possible in the single sweep mode.

This command is only available if external generator control is active (see `SOURce:EXTernal[:STATe]` on page 563).

Parameters:

<MeasType>

THRough
"TRANsmission" mode: calibration with direct connection between external generator and device input
"REFLection" mode: calibration with short circuit at the input

OPEN
only allowed in "REFLection" mode: calibration with open input

Example:

```
INIT:CONT OFF
```
Selects single sweep operation
```
CORR:METH TRAN
```
Selects a transmission measurement.
```
CORR:COLL THR;*WAI
```
Starts the measurement of reference data using direct connection between generator and device input and waits for the sweep end.

Usage: Setting only
SCPI confirmed

Manual operation: See "Calibrate Reflection Short" on page 225
See "Calibrate Reflection Open" on page 225

[SENSe:]CORRection:METHod

This command selects the type of measurement to be performed with the external generator.

This command is only available if external generator control is active (see `SOURce:EXTernal[:STATe]` on page 563).

Parameters:

REFLection
Selects reflection measurements.

TRANsmission
Selects transmission measurements.

*RST: TRANsmission

Example:

```
CORR:METH TRAN
```
Sets the type of measurement to "transmission".

Manual operation: See "Calibrate Transmission" on page 224
See "Calibrate Reflection Short" on page 225
See "Calibrate Reflection Open" on page 225

[SENSe:]CORRection:RECall

This command restores the measurement configuration used for calibration.

This command is only available if external generator control is active (see `SOURce:EXTernal[:STATe]` on page 563).

Example: CORR:REC

Usage: Event

Manual operation: See "Recall" on page 225

[SENSe:]CORRection[:STATe] <State>

This command turns correction of measurement results (normalization) on and off.

The command is available after you have created a reference trace for the selected measurement type with [SENSe:]CORRection:COLLect[:ACQuire] on page 558.

This command is only available if external generator control is active (see SOURce:EXTernal[:STATe] on page 563).

Parameters:

<State> ON | OFF

*RST: OFF

Example: CORR ON
Activates normalization.

Usage: SCPI confirmed

Manual operation: See "Source Calibration Normalize" on page 225

[SENSe:]CORRection:TRANsducer:GENerator <Name>

This command uses the normalized measurement data to generate a transducer factor with up to 1001 points. The trace data is converted to a transducer with unit dB and stored in a file with the specified name and the suffix .trd under c:\r_s\instr\trd. The frequency points are allocated in equidistant steps between start and stop frequency.

Parameters:

<Name> '<name>

Example: CORR:TRAN:GEN 'SMW200A1'
Creates the transducer file C:\r_s\instr\trd\SMW200A.trd.

Usage: SCPI confirmed

Manual operation: See "Save As Trd Factor" on page 226

SOURce:EXTernal:FREQuency <Frequency>

This command defines a fixed source frequency for the external generator.

Parameters:

<Frequency> Source frequency of the external generator.

*RST: 1100050000

Example: SOUR:EXT:FREQ 10MHz

Manual operation: See "(Manual) Source Frequency" on page 223

SOURce:EXTernal:FREQuency:COUPling[:STATe] <State>

This command couples the frequency of the external generator output to the R&S FSWP.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
Default setting: a series of frequencies is defined (one for each sweep point), based on the current frequency at the RF input of the R&S FSWP; the RF frequency range covers the currently defined span of the R&S FSWP (unless limited by the range of the signal generator)

OFF | 0
The generator uses a single fixed frequency, defined by `SOURce:EXTernal:FREQuency`.

*RST: 1

Example:
```
SOUR:EXT:FREQ:COUP ON
```

Manual operation: See "Source Frequency Coupling" on page 223

SOURce:EXTernal:FREQuency[:FACTor]:DENominator <Value>

This command defines the denominator of the factor with which the analyzer frequency is multiplied in order to obtain the transmit frequency of the selected generator.

Select the multiplication factor such that the frequency range of the generator is not exceeded if the following formula is applied to the start and stop frequency of the analyzer:

$$\text{Source Freq} = \text{RF} \cdot \frac{\text{Numerator}}{\text{Denominator}} + \text{Offset}$$

Parameters:

<Value> <numeric value>

*RST: 1

Example:
```
SOUR:EXT:FREQ:NUM 4
SOUR:EXT:FREQ:DEN 3
```
Sets a multiplication factor of 4/3, i.e. the transmit frequency of the generator is 4/3 times the analyzer frequency.

Manual operation: See "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 223

SOURce:EXTernal:FREQuency[:FACTor]:NUMerator <Value>

This command defines the numerator of the factor with which the analyzer frequency is multiplied in order to obtain the transmit frequency of the selected generator.

Select the multiplication factor such that the frequency range of the generator is not exceeded if the following formula is applied to the start and stop frequency of the analyzer:

$$\text{Source Freq} = \text{RF} \cdot \frac{\text{Numerator}}{\text{Denominator}} + \text{Offset}$$

Parameters:

<Value> <numeric value>

*RST: 1

Example: `SOUR:EXT:FREQ:NUM 4"`
`"SOUR:EXT:FREQ:DEN 3"`
Sets a multiplication factor of 4/3, i.e. the transmit frequency of the generator is 4/3 times the analyzer frequency.

Manual operation: See "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 223

SOURce:EXTernal:FREQuency:OFFSet <Offset>

This command defines the frequency offset of the generator with reference to the analyzer frequency.

Select the offset such that the frequency range of the generator is not exceeded if the following formula is applied to the start and stop frequency of the analyzer:

$$\text{Source Freq} = \text{RF} \cdot \frac{\text{Numerator}}{\text{Denominator}} + \text{Offset}$$

Parameters:

<Offset> <numeric value>, specified in Hz, kHz, MHz or GHz, rounded to the nearest Hz

*RST: 0 Hz

Example: `SOUR:EXT:FREQ:OFFS 10HZ`
Sets an offset of the generator output frequency compared to the analyzer frequency of 10 Hz.

Manual operation: See "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 223

SOURce:EXTernal:FREQuency:SWEep[:STATe] <State>

Note that this command is maintained for compatibility reasons only. It is not required in new remote control programs.

This command activates or deactivates the frequency sweep for the selected generator.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `SOUR:EXT:FREQ:SWE ON`
Activates the frequency sweep for the external generator.

SOURce:EXTernal:POWer[:LEVel] <Level>

This command sets the output power of the selected generator.

Parameters:
<Level> <numeric value>
*RST: -20 dBm

Example: `SOUR:EXT:POW -30dBm`
Sets the generator level to -30 dBm

Manual operation: See "Source Power" on page 223

SOURce:EXTernal[:STATe] <State>

This command activates or deactivates the connected external generator.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Source State" on page 222

SOURce:POWer[:LEVel][:IMMediate]:OFFSet <Offset>

This command defines a level offset for the external generator level. Thus, for example, attenuators or amplifiers at the output of the external generator can be taken into account for the setting.

Parameters:
<Offset> Range: -200 dB to +200 dB
*RST: 0dB

Example: `SOUR:POW:OFFS -10dB`
Sets the level offset of the external generator to – 20 dBm.

Usage: SCPI confirmed

Manual operation: See "Source Offset" on page 223

SOURce:EXTernal:ROSCillator[:SOURce] <Source>

This command controls selection of the reference oscillator for the external generator.

If the external reference oscillator is selected, the reference signal must be connected to the rear panel of the instrument.

Parameters:

<Source>

INTernal
the internal reference is used

EXTernal
the external reference is used; if none is available, an error flag is displayed in the status bar

*RST: INT

Example: `SOUR:EXT:ROSC EXT`
Switches to external reference oscillator

Manual operation: See "Reference" on page 221

SYSTem:COMMunicate:GPIB:RDEVice:GENerator:ADDRess <Number>

Changes the IEC/IEEE-bus address of the external generator.

Parameters:

<Number>

Range: 0 to 30
*RST: 28

Example: `SYST:COMM:GPIB:RDEV:GEN:ADDR 15`

Manual operation: See "GPIB Address / TCP/IP Address" on page 221

SYSTem:COMMunicate:RDEVice:GENerator:INTerface <Type>

Defines the interface used for the connection to the external generator.

This command is only available if external generator control is active (see `SOURce:EXTernal[:STATe]` on page 563).

Parameters:

<Type>

GPIB | TCPip
*RST: GPIB

Example: `SYST:COMM:RDEV:GEN:INT TCP`

Manual operation: See "Interface" on page 221

SYSTem:COMMunicate:RDEVice:GENerator:LINK <Type>

This command selects the link type of the external generator if the GPIB interface is used.

The difference between the two GPIB operating modes is the execution speed. While, during GPIB operation, each frequency to be set is transmitted to the generator separately, a whole frequency list can be programmed in one go if the TTL interface is also used. Frequency switching can then be performed per TTL handshake which results in considerable speed advantages.

This command is only available if external generator control is active (see SOURce:EXTernal[:STATe] on page 563).

Parameters:

<Type> GPIB | TTL

GPIB
GPIB connection without TTL synchronization (for all generators of other manufacturers and some Rohde & Schwarz devices)

TTL
GPIB connection with TTL synchronization (if available; for most Rohde&Schwarz devices)

*RST: GPIB

Example: SYST:COMM:RDEV:GEN:LINK TTL
Selects GPIB + TTL interface for generator operation.

Manual operation: See "TTL Handshake" on page 221

SYSTem:COMMunicate:RDEVice:GENerator:TYPE <Type>

This command selects the type of external generator.

For a list of the available generator types see "Overview of Supported Generators" on page 211.

Parameters:

<Name> <Generator name as string value>

*RST: SMU02

Example: SYST:COMM:RDEV:GEN:TYPE 'SMW06'
Selects SMW06 as an external generator

Manual operation: See "Generator Type" on page 221

SYSTem:COMMunicate:TCPip:RDEVice:GENerator:ADDRess <Address>

Configures the TCP/IP address for the external generator.

Parameters:

<Address> TCP/IP address between 0.0.0.0 and 0.255.255.255

*RST: 0.0.0.0

Example: SYST:COMM:TCP:RDEV:GEN:ADDR 130.094.122.195

Manual operation: See "GPIB Address / TCP/IP Address" on page 221

5.7.1.5 Configuring General Outputs

DIAGnostic:SERVice:NSOurce....566
OUTPut:IF:IFFRequency....566
OUTPut:IF[:SOURce]....566
OUTPut:TRIGger<port>:DIRection....567

OUTPut:TRIGger<port>:LEVel 567
OUTPut:TRIGger<port>:OTYPe 567
OUTPut:TRIGger<port>:PULSe:IMMediate 568
OUTPut:TRIGger<port>:PULSe:LENGth 568
OUTPut:UPORt[:VALue] 568
OUTPut:UPORt:STATe 569

DIAGnostic:SERVice:NSOurce <State>

This command turns the 28 V supply of the BNC connector labeled NOISE SOURCE CONTROL on the R&S FSWP on and off.

For details see chapter 3.2.1.2, "Input from Noise Sources", on page 195.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DIAG:SERV:NSO ON`

Manual operation: See "Noise Source" on page 236

OUTPut:IF:IFFRequency <Frequency>

This command defines the frequency for the IF output of the R&S FSWP. The IF frequency of the signal is converted accordingly.

This command is available in the time domain and if the IF/VIDEO/DEMOD output is configured for IF.

For more information see chapter 3.2.1.4, "IF and Video Signal Output", on page 196.

Parameters:

<Frequency> *RST: 50.0 MHz

Manual operation: See "IF (Wide) Out Frequency" on page 236

OUTPut:IF[:SOURce] <Source>

Defines the type of signal available at the IF/VIDEO/DEMOD or IF OUT 2 GHZ connector of the R&S FSWP.

Parameters:

<Source>

IF
The measured IF value is available at the IF/VIDEO/DEMOD output connector.

VIDeo
The displayed video signal (i.e. the filtered and detected IF signal, 200mV) is available at the IF/VIDEO/DEMOD output connector.
This setting is required to provide demodulated audio frequencies at the output.

*RST: IF

Example: `OUTP:IF VID`
Selects the video signal for the IF/VIDEO/DEMOD output connector.

Manual operation: See "IF/Video Output" on page 235

OUTPut:TRIGger<port>:DIRection <Direction>

This command selects the trigger direction for trigger ports that serve as an input as well as an output.

Suffix:
<port> Selects the used trigger port.
<2>: selects trigger port 2 (on the rear panel).

Parameters:
<Direction> **INPut**
Port works as an input.

OUTPut
Port works as an output.

*RST: INPut

Manual operation: See "Trigger 1/2" on page 236

OUTPut:TRIGger<port>:LEVel <Level>

This command defines the level of the signal generated at the trigger output.

This command works only if you have selected a user defined output with `OUTPut:TRIGger<port>:OTYPe`.

Suffix:
<port> Selects the trigger port to which the output is sent.
2 = trigger port 2 (rear)

Parameters:
<Level> **HIGH**
TTL signal.

LOW
0 V

*RST: LOW

Manual operation: See "Trigger 1/2" on page 236
See "Level" on page 237

OUTPut:TRIGger<port>:OTYPe <OutputType>

This command selects the type of signal generated at the trigger output.

Suffix:
<port> Selects the trigger port to which the output is sent.
2 = trigger port 2 (rear panel)

Parameters:

<OutputType>

DEVice
Sends a trigger signal when the R&S FSWP has triggered internally.

TARMed
Sends a trigger signal when the trigger is armed and ready for an external trigger event.

UDEFined
Sends a user defined trigger signal. For more information see `OUTPut:TRIGger<port>:LEVel`.

*RST: DEVice

Manual operation: See "Output Type" on page 236

OUTPut:TRIGger<port>:PULSe:IMMediate

This command generates a pulse at the trigger output.

Suffix:

<port>

Selects the trigger port to which the output is sent.
2 = trigger port 2 (rear)

Usage: Event

Manual operation: See "Send Trigger" on page 237

OUTPut:TRIGger<port>:PULSe:LENGth <Length>

This command defines the length of the pulse generated at the trigger output.

Suffix:

<port>

Selects the trigger port to which the output is sent.
2 = trigger port 2 (rear)

Parameters:

<Length>

Pulse length in seconds.

Manual operation: See "Pulse Length" on page 237

OUTPut:UPORt[:VALue] <Value>

This command sets the control lines of the user ports.

The assignment of the pin numbers to the bits is as follows:

Bit	7	6	5	4	3	2	1	0
Pin	N/A	N/A	5	3	4	7	6	2

Bits 7 and 6 are not assigned to pins and must always be 0.

The user port is written to with the given binary pattern. If the user port is programmed to input instead of output (see `INPut:UPORt:STATe` on page 547), the output value is temporarily stored.

Parameters:

<Value> bit values in hexadecimal format
TTL type voltage levels (max. 5V)
Range: #B00000000 to #B00111111

Example: `OUTP:UPOR #B00100100`
Sets pins 5 and 7 to 5 V.

OUTPut:UPORt:STATe <State>

This command toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S FSWP.

Parameters:

<State> **ON**
User port is switched to OUTPut
OFF
User port is switched to INPut
*RST: OFF

5.7.1.6 Programming Example for External Generator Control

The following example demonstrates how to work with an external generator in a remote environment.

5.7.2 Defining the Frequency

[SENSe:]FREQuency:CENTer....570
[SENSe:]FREQuency:CENTer:STEP....570
[SENSe:]FREQuency:CENTer:STEP:AUTO....570
[SENSe:]FREQuency:CENTer:STEP:LINK....571
[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor....571
[SENSe:]FREQuency:OFFSet....571
[SENSe:]FREQuency:SPAN....572
[SENSe:]FREQuency:SPAN:FULL....572
[SENSe:]FREQuency:STARt....572
[SENSe:]FREQuency:STOP....573
CALCulate<n>:MARKer<m>:FUNCtion:CENTer....573
CALCulate<n>:MARKer<m>:FUNCtion:CSTep....573
CALCulate<n>:MARKer<m>:FUNCtion:STRack[:STATe]....573
CALCulate<n>:MARKer<m>:FUNCtion:STRack:BANDwidth....574
CALCulate<n>:MARKer<m>:FUNCtion:STRack:THReshold....574
CALCulate<n>:MARKer<m>:FUNCtion:STRack:TRACe....574
DISPlay[:WINDow<n>]:TRACe:X:SPACing....574

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency.

Parameters:

<Frequency> The allowed range and f_{max} is specified in the data sheet.

UP
Increases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

DOWN
Decreases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

*RST: fmax/2
Default unit: Hz

Example:

```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

Sets the center frequency to 110 MHz.

Usage: SCPI confirmed

Manual operation: See "Center frequency" on page 242
See "Frequency" on page 279

[SENSe:]FREQuency:CENTer:STEP <StepSize>

This command defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the `SENS:FREQ UP` AND `SENS:FREQ DOWN` commands, see `[SENSe:]FREQuency:CENTer` on page 570.

Parameters:

<StepSize> f_{max} is specified in the data sheet.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example:

```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

Sets the center frequency to 110 MHz.

Manual operation: See "Center Frequency Stepsize" on page 243

[SENSe:]FREQuency:CENTer:STEP:AUTO <State>

This command couples or decouples the center frequency step size to the span.

In time domain (zero span) measurements, the center frequency is coupled to the RBW.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example: `FREQ:CENT:STEP:AUTO ON`
Activates the coupling of the step size to the span.

[SENSe:]FREQuency:CENTer:STEP:LINK <CouplingType>

This command couples and decouples the center frequency step size to the span or the resolution bandwidth.

Parameters:

<CouplingType>

SPAN
Couples the step size to the span. Available for measurements in the frequency domain.

RBW
Couples the step size to the resolution bandwidth. Available for measurements in the time domain.

OFF
Decouples the step size.

*RST: SPAN

Example: `FREQ:CENT:STEP:LINK SPAN`

Manual operation: See "Center Frequency Stepsize" on page 243

[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <Factor>

This command defines a step size factor if the center frequency step size is coupled to the span or the resolution bandwidth.

Parameters:

<Factor> 1 to 100 PCT

*RST: 10

Example: `FREQ:CENT:STEP:LINK:FACT 20PCT`

Manual operation: See "Center Frequency Stepsize" on page 243

[SENSe:]FREQuency:OFFSet <Offset>

This command defines a frequency offset.

If this value is not 0 Hz, the application assumes that the input signal was frequency shifted outside the application. All results of type "frequency" will be corrected for this shift numerically by the application.

See also "Frequency Offset" on page 244.

Note: In MSRA mode, the setting command is only available for the MSRA Master. For MSRA applications, only the query command is available.

Parameters:

<Offset> Range: -100 GHz to 100 GHz
*RST: 0 Hz

Example: `FREQ:OFFS 1GHZ`

Usage: SCPI confirmed

Manual operation: See "Frequency Offset" on page 244

[SENSe:]FREQuency:SPAN <Span>

This command defines the frequency span.

If you set a span of 0 Hz in the Spectrum application, the R&S FSWP starts a measurement in the time domain.

Parameters:

<Span> The minimum span for measurements in the frequency domain is 10 Hz. For SEM and spurious emission measurements, the minimum span is 20 Hz.

Range: 0 Hz to fmax
*RST: Full span

Usage: SCPI confirmed

Manual operation: See "Zero Span" on page 13
See "Span" on page 242
See "Zero Span" on page 243
See "Last Span" on page 243

[SENSe:]FREQuency:SPAN:FULL

This command restores the full span.

Usage: Event
SCPI confirmed

Manual operation: See "Full Span" on page 243

[SENSe:]FREQuency:STARt <Frequency>

This command defines a start frequency for measurements in the frequency domain.

Parameters:

<Frequency> 0 to (fmax - min span)

*RST: 0

Example: `FREQ:STAR 20MHz`

Usage: SCPI confirmed

Manual operation: See "Frequency Sweep" on page 13
See "Start / Stop" on page 242

[SENSe:]FREQuency:STOP <Frequency>

This command defines a stop frequency for measurements in the frequency domain.

Parameters:
<Frequency> min span to fmax
*RST: fmax

Example: `FREQ:STOP 2000 MHz`

Usage: SCPI confirmed

Manual operation: See "Frequency Sweep" on page 13
See "Start / Stop" on page 242

CALCulate<n>:MARKer<m>:FUNCtion:CENTer

This command matches the center frequency to the frequency of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Example: `CALC:MARK2:FUNC:CENT`
Sets the center frequency to the frequency of marker 2.

Usage: Event

Manual operation: See "Harmonic Distortion" on page 16
See "Center Frequency = Marker Frequency" on page 369

CALCulate<n>:MARKer<m>:FUNCtion:CSTep

This command matches the center frequency step size to the current marker frequency.

The command turns delta markers into normal markers.

Usage: Event

CALCulate<n>:MARKer<m>:FUNCtion:STRack[:STATe] <State>

This command turns signal tracking on and off.

(<n>, <m> are irrelevant.)

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Signal Tracking State" on page 244

CALCulate<n>:MARKer<m>:FUNCtion:STRack:BANDwidth <Bandwidth>

This command defines the bandwidth around the center frequency that is included in the signal tracking process.

(<n>, <m> are irrelevant.)

Note that you have to turn on signal tracking before you can use the command.

Parameters:

<Bandwidth>
Range: 10 Hz to Max span
*RST: (= span/10 on activating the function)
Default unit: Hz

Manual operation: See "Tracking Bandwidth" on page 245

CALCulate<n>:MARKer<m>:FUNCtion:STRack:THReshold <Level>

This command defines the threshold level for the signal tracking process.

(<n>, <m> are irrelevant.)

Note that you have to turn on signal tracking before you can use the command.

Parameters:

<Level>
The unit depends on `CALCulate<n>:UNIT:POWer`.
Range: -130 dBm to 30 dBm
*RST: -120 dBm

Manual operation: See "Tracking Threshold" on page 245

CALCulate<n>:MARKer<m>:FUNCtion:STRack:TRACe <TraceNumber>

This command selects the trace on which the largest signal is searched for.

(<n>, <m> are irrelevant.)

Parameters:

<TraceNumber>
1 to 6
Range: 1 to 6
*RST: 1

Manual operation: See "Signal Track Trace" on page 245

DISPlay[:WINDow<n>]:TRACe:X:SPACing <ScalingType>

This command selects the scaling of the x-axis.

Parameters:

<ScalingType>

LOGarithmic
Logarithmic scaling.

LINear
Linear scaling.

*RST: LINear

Example: `DISP:TRAC:X:SPAC LOG`

Manual operation: See "Frequency Axis Scaling" on page 242

5.7.3 Amplitude Settings

Remote commands to configure level characteristics described elsewhere:

- `INPut:COUPling` on page 545

[SENSe:]POWer:NCORrection 575
CALCulate<n>:MARKer<m>:FUNCtion:REFerence 575
CALCulate<n>:UNIT:POWer 576
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel 576
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet 576
INPut:ATTenuation 577
INPut:ATTenuation:AUTO 577
INPut:GAIN[:VALue] 577
INPut:GAIN:STATe 578

[SENSe:]POWer:NCORrection <State>

This command turns noise cancellation on and off.

If noise cancellation is on, the R&S FSWP performs a reference measurement to determine its inherent noise and subtracts the result from the channel power measurement result (first active trace only).

For more information see "Noise cancellation" on page 56.

Parameters:

<State>

ON | OFF

*RST: OFF

Example: `POW:NCOR ON`

Manual operation: See "Noise cancellation" on page 56

CALCulate<n>:MARKer<m>:FUNCtion:REFerence

This command matches the reference level to the power level of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Example: `CALC:MARK2:FUNC:REF`
Sets the reference level to the level of marker 2.

Usage: Event

Manual operation: See "Reference Level = Marker Level" on page 369

CALCulate<n>:UNIT:POWer <Unit>

This command selects the unit of the y-axis.

The unit applies to all power-based measurement windows (regardless of the <n> suffix).

Parameters:
<Unit> DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere

*RST: dBm

Example: `CALC:UNIT:POW DBM`
Sets the power unit to dBm.

Manual operation: See "Unit" on page 251

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel <ReferenceLevel>

This command defines the reference level (for all traces, <t> is irrelevant).

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Parameters:
<ReferenceLevel> The unit is variable.

Range: see datasheet
*RST: 0 dBm

Example: `DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

Manual operation: See "Reference Level" on page 250

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Offset>

This command defines a reference level offset (for all traces, <t> is irrelevant).

Parameters:
<Offset> Range: -200 dB to 200 dB
*RST: 0dB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Shifting the Display (Offset)" on page 164
See "Shifting the Display (Offset)" on page 250

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If you set the attenuation manually, it is no longer coupled to the reference level, but the reference level is coupled to the attenuation. Thus, if the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:

<Attenuation>
Range: see data sheet
Increment: 5 dB
*RST: 10 dB (AUTO is set to ON)

Example: `INP:ATT 30dB`
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuation Mode / Value" on page 251

INPut:ATTenuation:AUTO <State>

This command couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S FSWP determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

Parameters:

<State>
ON | OFF | 0 | 1
*RST: 1

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuation Mode / Value" on page 251

INPut:GAIN[:VALue] <Gain>

This command selects the gain level if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 578).

The command requires the additional preamplifier hardware option.

Parameters:

<Gain>
15 dB | 30 dB
The availability of gain levels depends on the model of the R&S FSWP.
R&S FSWP8: 15dB and 30 dB
R&S FSWP26 or higher: 30 dB
*RST: OFF

Example: `INP:GAIN:VAL 30`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Preamplifier" on page 252

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off. It requires the optional preamplifiier hardware.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `INP:GAIN:STAT ON`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Preamplifier" on page 252

5.7.4 Scaling the Y-Axis

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] 578
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE 578
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE 579
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition 579
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue 579
DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing 580

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] <Range>

This command defines the display range of the y-axis (for all traces, <t> is irrelevant).

Note that the command works only for a logarithmic scaling. You can select the scaling with `DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing`.

Parameters:
<Range> Range: 1 dB to 200 dB
*RST: 100 dB

Example: `DISP:TRAC:Y 110dB`

Usage: SCPI confirmed

Manual operation: See "Range" on page 253

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE

Automatic scaling of the y-axis is performed once, then switched off again (for all traces, <t> is irrelevant).

Usage: SCPI confirmed

Manual operation: See "Auto Scale Once" on page 253

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE <Mode>

This command selects the type of scaling of the y-axis (for all traces, <t> is irrelevant).

When the display update during remote control is off, this command has no immediate effect.

Parameters:

<Mode>
ABSolute
absolute scaling of the y-axis
RELative
relative scaling of the y-axis
*RST: ABSolute

Example:
```
DISP:TRAC:Y:MODE REL
```

Manual operation: See "Scaling" on page 254

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition <Position>

This command defines the vertical position of the reference level on the display grid (for all traces, <t> is irrelevant).

The R&S FSWP adjusts the scaling of the y-axis accordingly.

For measurements with the optional external generator control, the command defines the position of the reference value.

Parameters:

<Position>
0 PCT corresponds to the lower display border, 100% corresponds to the upper display border.
*RST: 100 PCT = frequency display; 50 PCT = time display

Example:
```
DISP:TRAC:Y:RPOS 50PCT
```

Usage: SCPI confirmed

Manual operation: See "Reference Position" on page 226
See "Ref Level Position" on page 253

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue <Value>

The command defines the power value assigned to the reference position in the grid (for all traces, <t> is irrelevant).

For external generator calibration measurements (requires the optional External Generator Control), this command defines the power offset value assigned to the reference position.

Parameters:

<Value> *RST: 0 dBm, coupled to reference level

Example: `DISP:TRAC:Y:RVAL -20dBm`
Sets the power value assigned to the reference position to -20 dBm

Manual operation: See "Reference Value" on page 226

DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing <ScalingType>

This command selects the scaling of the y-axis (for all traces, <t> is irrelevant).

Parameters:

<ScalingType>

LOGarithmic
Logarithmic scaling.

LINear
Linear scaling in %.

LDB
Linear scaling in the specified unit.

PERCent
Linear scaling in %.

*RST: LOGarithmic

Example: `DISP:TRAC:Y:SPAC LIN`
Selects linear scaling in %.

Usage: SCPI confirmed

Manual operation: See "Scaling" on page 254

5.7.5 Remote Commands to Define Filter Characteristics

[SENSe:]BWIDth[:RESolution] 581
[SENSe:]BANDwidth[:RESolution] 581
[SENSe:]BWIDth[:RESolution]:AUTO 581
[SENSe:]BANDwidth[:RESolution]:AUTO 581
[SENSe:]BWIDth[:RESolution]:RATio 581
[SENSe:]BANDwidth[:RESolution]:RATio 581
[SENSe:]BWIDth[:RESolution]:TYPE 582
[SENSe:]BANDwidth[:RESolution]:TYPE 582
[SENSe:]BWIDth:VIDeo 582
[SENSe:]BANDwidth:VIDeo 582
[SENSe:]BWIDth:VIDeo:AUTO 582
[SENSe:]BANDwidth:VIDeo:AUTO 582
[SENSe:]BWIDth:VIDeo:RATio 583
[SENSe:]BANDwidth:VIDeo:RATio 583
[SENSe:]BWIDth:VIDeo:TYPE 583
[SENSe:]BANDwidth:VIDeo:TYPE 583

[SENSe:]BWIDth[:RESolution] <Bandwidth>
[SENSe:]BANDwidth[:RESolution] <Bandwidth>

This command defines the resolution bandwidth and decouples the resolution bandwidth from the span.

For statistics measurements, this command defines the **demodulation** bandwidth.

Parameters:
<Bandwidth> refer to data sheet
*RST: RBW: AUTO is set to ON; DBW: 3MHz

Example: `BAND 1 MHz`
Sets the resolution bandwidth to 1 MHz

Usage: SCPI confirmed

Manual operation: See "Analysis Bandwidth" on page 160
See "RBW" on page 263
See "RBW" on page 279

[SENSe:]BWIDth[:RESolution]:AUTO <State>
[SENSe:]BANDwidth[:RESolution]:AUTO <State>

This command couples and decouples the resolution bandwidth to the span.

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `BAND:AUTO OFF`
Switches off the coupling of the resolution bandwidth to the span.

Usage: SCPI confirmed

Manual operation: See "RBW" on page 263
See "Default Coupling" on page 265

[SENSe:]BWIDth[:RESolution]:RATio <Ratio>
[SENSe:]BANDwidth[:RESolution]:RATio <Ratio>

This command defines the ratio between the resolution bandwidth (Hz) and the span (Hz).

Note that the ratio defined with this remote command (RBW/span) is reciprocal to that of the coupling ratio (span/RBW).

Parameters:
<Ratio> Range: 0.0001 to 1
*RST: 0.01

Example: `BAND:RAT 0.1`

Usage: SCPI confirmed

Manual operation: See "Span/RBW" on page 264

[SENSe:]BWIDth[:RESolution]:TYPE <FilterType>
[SENSe:]BANDwidth[:RESolution]:TYPE <FilterType>

This command selects the resolution filter type.

When you change the filter type, the command selects the next larger filter bandwidth if the same bandwidth is unavailable for that filter.

Parameters:

<FilterType>

CFILter
Channel filters
Available in the Spectrum application.

NORMal
3 dB Gauss filters

P5
5-pole filters
Available for FFT sweeps in the Spectrum application.

RRC
RRC filters

*RST: Depends on application

Example:
```
BAND:TYPE NORM
```

Manual operation: See "Filter Type" on page 264

[SENSe:]BWIDth:VIDeo <Bandwidth>
[SENSe:]BANDwidth:VIDeo <Bandwidth>

This command defines the video bandwidth.

The command decouples the video bandwidth from the resolution bandwidths.

Parameters:

<Bandwidth> refer to data sheet

*RST: AUTO is set to ON

Example:
```
BAND:VID 10 kHz
```

Usage: SCPI confirmed

Manual operation: See "VBW" on page 263

[SENSe:]BWIDth:VIDeo:AUTO <State>
[SENSe:]BANDwidth:VIDeo:AUTO <State>

This command couples and decouples the video bandwidth to the resolution bandwidth.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example: `BAND:VID:AUTO OFF`

Usage: SCPI confirmed

Manual operation: See "VBW" on page 263
See "RBW/VBW " on page 264
See "Default Coupling" on page 265

[SENSe:]BWIDth:VIDeo:RATio <Ratio>
[SENSe:]BANDwidth:VIDeo:RATio <Ratio>

This command defines the coupling ratio of the video bandwidth to the resolution bandwidth (RBW/VBW).

Parameters:
<Ratio> Range: 0,001 to 1000
*RST: 1

Example: `BAND:VID:RAT 3`
Sets the coupling of video bandwidth to video bandwidth = 3*resolution bandwidth

Usage: SCPI confirmed

Manual operation: See "RBW/VBW " on page 264

[SENSe:]BWIDth:VIDeo:TYPE <Mode>
[SENSe:]BANDwidth:VIDeo:TYPE <Mode>

This command selects the position of the video filter in the signal path.

Parameters:
<Mode>

LINear
The video filter is applied in front of the logarithmic amplifier.
In linear mode, measurements with a logarithmic level scale result in flatter falling edges compared to logarithmic mode. The reason is the conversion of linear power values into logarithmic level values: if you halve the linear power, the logarithmic level decreases by 3 dB.

LOGarithmic
The video filter is applied after the logarithmic amplifier

*RST: LOGarithmic

Example: `BAND:VID:TYPE LIN`
Video filter ahead of the logarithmic amplifier

5.7.6 Remote Commands to Control a Measurement

[SENSe:]AVERage<n>:COUNt....584
[SENSe:]AVERage<n>[:STATe<t>]....584
[SENSe:]AVERage<n>:TYPE....584
[SENSe:]BWIDth[:RESolution]:FFT....585

[SENSe:]BANDwidth[:RESolution]:FFT....585
[SENSe:]SWEep:COUNt....585
[SENSe:]SWEep:DURation?....586
[SENSe:]SWEep:OPTimize....586
[SENSe:]SWEep:POINts....587
[SENSe:]SWEep:TIME....588
[SENSe:]SWEep:TIME:AUTO....588
[SENSe:]SWEep:TYPE....588
[SENSe:]SWEep:TYPE:USED....589

[SENSe:]AVERage<n>:COUNt <AverageCount>

This command defines the number of measurements that the application uses to average traces (for all windows, <n> is irrelevant).

In case of continuous sweep mode, the application calculates the moving average over the average count.

In case of single sweep mode, the application stops the measurement and calculates the average after the average count has been reached.

Parameters:

<AverageCount> If you set a average count of 0 or 1, the application performs one single measurement in single sweep mode.
In continuous sweep mode, if the average count is set to 0, a moving average over 10 measurements is performed.

Range: 0 to 200000
*RST: 0

Usage: SCPI confirmed

Manual operation: See "Sweep / Average Count" on page 265
See "Average Count" on page 329

[SENSe:]AVERage<n>[:STATe<t>] <State>

This command turns averaging for a particular trace in a particular window on and off.

Parameters:

<State> ON | OFF

Usage: SCPI confirmed

[SENSe:]AVERage<n>:TYPE <Mode>

This command selects the trace averaging mode.

Parameters:

<Mode>

VIDeo
The logarithmic power values are averaged.

LINear
The power values are averaged before they are converted to logarithmic values.

POWer
The power level values are converted into unit Watt prior to averaging. After the averaging, the data is converted back into its original unit.

*RST: VIDeo

Example: `AVER:TYPE LIN`
Switches to linear average calculation.

Usage: SCPI confirmed

Manual operation: See "Average Mode" on page 329

[SENSe:]BWIDth[:RESolution]:FFT <FilterMode>
[SENSe:]BANDwidth[:RESolution]:FFT <FilterMode>

Defines the filter mode to be used for FFT filters by defining the partial span size. The partial span is the span which is covered by one FFT analysis.

This command is only available when using the sweep type "FFT".

Note: this command is maintained for compatibility reasons only. For new remote control programs, use the `[SENSe:]SWEep:OPTimize` command.

Parameters:

<FilterMode> WIDE | AUTO | NARRow

AUTO
Automatically applies the sweep optimization mode that is best for the current measurement.

NARRow
Optimizes the sweep mode for a large dynamic range.

WIDE
Optimizes the sweep mode for high performance.

*RST: AUTO

Example: `BAND:TYPE FFT`
Select FFT filter.

Example: `BAND:FFT NARR`
Select narrow partial span for FFT filter.

[SENSe:]SWEep:COUNt <SweepCount>

This command defines the number of measurements that the application uses to average traces.

In case of continuous measurement mode, the application calculates the moving average over the average count.

In case of single measurement mode, the application stops the measurement and calculates the average after the average count has been reached.

Parameters:

<SweepCount> When you set a sweep count of 0 or 1, the R&S FSWP performs one single measurement in single measurement mode.
In continuous measurement mode, if the sweep count is set to 0, a moving average over 10 measurements is performed.

Range: 0 to 200000
*RST: 0

Example:
```
SWE:COUN 64
```
Sets the number of measurements to 64.
```
INIT:CONT OFF
```
Switches to single measurement mode.
```
INIT;*WAI
```
Starts a measurement and waits for its end.

Usage: SCPI confirmed

Manual operation: See "Sweep / Average Count" on page 265

[SENSe:]SWEep:DURation? <Time>

This command provides an estimation of the total time required to capture the data and process it. This time span may be considerably longer than the actual sweep time (see `[SENSe:]SWEep:TIME` on page 588).

Tip: To determine the necessary timeout for data capturing in a remote control program, double the estimated time and add 1 second.

Return values:

<Time>

Example:
```
SWE:TIME 1s
SWE:DUR?
```
Reply:
```
27.9734842578
```

Usage: Query only

Manual operation: See "Data capturing takes too long" on page 679

[SENSe:]SWEep:OPTimize <Mode>

In FFT mode, several FFT analysis steps are required to cover the entire measurement span. The span which is covered by one FFT analysis step is called *partial span*. The partial span cannot be defined directly, but it can be optimized according to measurement requirements.

Table 5-3: Optimization parameters in FFT mode

Optimization mode	Description
Dynamic	Optimizes the dynamic range by using the narrowest possible partial span (depending on the RBW). The autorange function for the internal IF gain calculation is activated to obtain the best control range for the A/D converter.
Speed	Optimizes the sweep rate by using the widest possible partial span (depending on the RBW). The autorange function for the internal IF gain calculation is deactivated. (Note: set the reference level accordingly to optimize the control range for the A/D converter). It is recommended that you set the sweep time to "Auto" to optimize the sweep rate (see `[SENSe:]SWEep:TIME:AUTO` on page 588).
Auto	Uses a medium-sized partial span to obtain a compromise between a large dynamic range and a fast sweep rate. The autorange function for the internal IF gain calculation is activated to obtain the best control range for the A/D converter.

Zero span mode

For zero span measurements, the optimization mode defines the selection of the A/D converter prefilter.

Table 5-4: Optimization parameters in zero span mode

Optimization mode	Description
Dynamic	The narrowest filter possible (depending on the RBW) is used.
Speed	The widest filter possible (depending on the RBW) is used.
Auto	A medium-sized prefilter is used.

Parameters:
<Mode> *RST: AUTO

Example: `SWE:OPT DYN`
Selects optimization for dynamic range.

Manual operation: See "Optimization" on page 266

[SENSe:]SWEep:POINts <SweepPoints>

This command defines the number of measurement points to analyze after a measurement.

Note that the number of measurement points is limited to 10001 when measuring spurious emissions.

Example: `SWE:POIN 251`

Usage: SCPI confirmed

Manual operation: See "Sweep Points" on page 265

[SENSe:]SWEep:TIME <Time>

This command defines the measurement time.

In the Spectrum application, the command decouples the sweep time from the span and resolution and video bandwidths. Note that this command queries only the time required to capture the data, not to process it. To obtain an estimation of the total capture and processing time, use the `[SENSe:]SWEep:DURation?` command.

Parameters:

<Time> refer to data sheet

*RST: depends on current settings (determined automatically)

Example: `SWE:TIME 10s`

Usage: SCPI confirmed

Manual operation: See "Sweep Time" on page 58
See "Sweep Time" on page 279

[SENSe:]SWEep:TIME:AUTO <State>

This command couples and decouples the sweep time to the span and the resolution and video bandwidths.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example: `SWE:TIME:AUTO ON`
Activates automatic sweep time.

Usage: SCPI confirmed

Manual operation: See "Harmonic Sweep Time" on page 178
See "Sweep Time" on page 263
See "Default Coupling" on page 265

[SENSe:]SWEep:TYPE <Type>

This command selects the sweep type.

Parameters:

<Type>

AUTO
Automatic selection of the sweep type between sweep mode and FFT.

FFT
FFT mode

SWE
Sweep list

*RST: AUTO

Example: `SWE:TYPE FFT`

Manual operation: See "Sweep Type" on page 266

[SENSe:]SWEep:TYPE:USED

This command queries the sweep type if you have turned on automatic selection of the sweep type.

Return values:

<Type>
SWE
Normal sweep
FFT
FFT mode

5.7.7 Trigger Configuration

- Configuring Trigger Conditions 589
- Configuring Gated Measurements 594
- Configuring Trigger Output 596

5.7.7.1 Configuring Trigger Conditions

TRIGger[:SEQuence]:DTIMe 589
TRIGger[:SEQuence]:HOLDoff[:TIME] 590
TRIGger[:SEQuence]:IFPower:HOLDoff 590
TRIGger[:SEQuence]:IFPower:HYSTeresis 590
TRIGger[:SEQuence]:LEVel[:EXTernal<port>] 591
TRIGger[:SEQuence]:LEVel:IFPower 591
TRIGger[:SEQuence]:LEVel:IQPower 591
TRIGger[:SEQuence]:LEVel:RFPower 592
TRIGger[:SEQuence]:LEVel:VIDeo 592
TRIGger[:SEQuence]:SLOPe 592
TRIGger[:SEQuence]:SOURce 592
TRIGger[:SEQuence]:TIME:RINTerval 593

TRIGger[:SEQuence]:DTIMe <DropoutTime>

Defines the time the input signal must stay below the trigger level before a trigger is detected again.

Parameters:

<DropoutTime> Dropout time of the trigger.

Range: 0 s to 10.0 s
*RST: 0 s

Manual operation: See "Drop-Out Time" on page 282

TRIGger[:SEQuence]:HOLDoff[:TIME] <Offset>

Defines the time offset between the trigger event and the start of the measurement.

A negative offset is possible for time domain measurements.

For the trigger sources "External" or "IF Power", a common input signal is used for both trigger and gate. Therefore, changes to the gate delay will affect the trigger offset as well.

Parameters:

<Offset> For measurements in the frequency domain, the range is 0 s to 30 s.
For measurements in the time domain, the range is the negative measurement time to 30 s.
*RST: 0 s

Example: `TRIG:HOLD 500us`

Manual operation: See "Trigger Offset" on page 282

TRIGger[:SEQuence]:IFPower:HOLDoff <Period>

This command defines the holding time before the next trigger event.

Note that this command can be used for **any trigger source**, not just IF Power (despite the legacy keyword).

Note: If you perform gated measurements in combination with the IF Power trigger, the R&S FSWP ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q data measurements.

Parameters:

<Period> Range: 0 s to 10 s
*RST: 0 s

Example: `TRIG:SOUR EXT`
Sets an external trigger source.
`TRIG:IFP:HOLD 200 ns`
Sets the holding time to 200 ns.

Manual operation: See "Trigger Holdoff" on page 283

TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

This command defines the trigger hysteresis, which is only available for "IF Power" trigger sources.

Parameters:

<Hysteresis> Range: 3 dB to 50 dB
*RST: 3 dB

Example: `TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HYST 10DB`
Sets the hysteresis limit value.

Manual operation: See "Hysteresis" on page 283

TRIGger[:SEQuence]:LEVel[:EXTernal<port>] <TriggerLevel>

This command defines the level the external signal must exceed to cause a trigger event.

Suffix:
<port> Selects the trigger port.
1 = trigger port 1 (TRIGGER INPUT connector on front panel)
2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on rear panel)

Parameters:
<TriggerLevel> Range: 0.5 V to 3.5 V
*RST: 1.4 V

Example: `TRIG:LEV 2V`

Manual operation: See "Trigger Level" on page 282

TRIGger[:SEQuence]:LEVel:IFPower <TriggerLevel>

This command defines the power level at the third intermediate frequency that must be exceeded to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Parameters:
<TriggerLevel> For details on available trigger levels and trigger bandwidths see the data sheet.
*RST: -10 dBm

Example: `TRIG:LEV:IFP -30DBM`

Manual operation: See "Trigger Level" on page 282

TRIGger[:SEQuence]:LEVel:IQPower <TriggerLevel>

This command defines the magnitude the I/Q data must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

Parameters:
<TriggerLevel> Range: -130 dBm to 30 dBm
*RST: -20 dBm

Example: `TRIG:LEV:IQP -30DBM`

Manual operation: See "Trigger Level" on page 282

TRIGger[:SEQuence]:LEVel:RFPower <TriggerLevel>

This command defines the power level the RF input must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

The input signal must be between 500 MHz and 8 GHz.

Parameters:

<TriggerLevel> For details on available trigger levels and trigger bandwidths see the data sheet.

*RST: -20 dBm

Example: `TRIG:LEV:RFP -30dBm`

Manual operation: See "Trigger Level" on page 282

TRIGger[:SEQuence]:LEVel:VIDeo <Level>

This command defines the level the video signal must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

Parameters:

<Level> Range: 0 PCT to 100 PCT

*RST: 50 PCT

Example: `TRIG:LEV:VID 50PCT`

TRIGger[:SEQuence]:SLOPe <Type>

This command selects the trigger slope.

Parameters:

<Type> POSitive | NEGative

POSitive
Triggers when the signal rises to the trigger level (rising edge).

NEGative
Triggers when the signal drops to the trigger level (falling edge).

*RST: POSitive

Example: `TRIG:SLOP NEG`

Manual operation: See "Slope" on page 283

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

For details on trigger sources see "Trigger Source" on page 279.

Note on external triggers:

If a measurement is configured to wait for an external trigger signal in a remote control program, remote control is blocked until the trigger is received and the program can continue. Make sure this situation is avoided in your remote control programs.

For troubleshooting tips see "Uncompleted sequential commands - blocked remote channels" on page 676.

Parameters:

<Source>

IMMediate
Free Run

EXT | EXT2
Trigger signal from one of the TRIGGER INPUT/OUTPUT connectors.
Note: Connector must be configured for "Input".

RFPower
First intermediate frequency

IFPower
Second intermediate frequency

VIDeo
Video mode is available in the time domain and only in the Spectrum application.

PSEN
External power sensor

*RST: IMMediate

Example:

```
TRIG:SOUR EXT
```

Selects the external trigger input as source of the trigger signal

Manual operation:

See "Using the power sensor as an external trigger" on page 204
See "Trigger Source" on page 279
See "Free Run" on page 280
See "Ext. Trigger 1/2" on page 280
See "Video" on page 280
See "IF Power" on page 280
See "RF Power" on page 281
See "Power Sensor" on page 281
See "Time" on page 282

TRIGger[:SEQuence]:TIME:RINTerval <Interval>

This command defines the repetition interval for the time trigger.

Parameters:

<Interval>

2.0 ms to 5000

Range: 2 ms to 5000 s
*RST: 1.0 s

Example: `TRIG:SOUR TIME`
Selects the time trigger input for triggering.
`TRIG:TIME:RINT 50`
The measurement starts every 50 s.

Manual operation: See "Repetition Interval" on page 282

5.7.7.2 Configuring Gated Measurements

[SENSe:]SWEep:EGATe 594
[SENSe:]SWEep:EGATe:HOLDoff 594
[SENSe:]SWEep:EGATe:LENGth 595
[SENSe:]SWEep:EGATe:POLarity 595
[SENSe:]SWEep:EGATe:SOURce 595
[SENSe:]SWEep:EGATe:TYPE 596

[SENSe:]SWEep:EGATe <State>

This command turns gated measurements on and off.

In case of measurements with an external gate, the measured values are recorded as long as the gate is opened. During a sweep the gate can be opened and closed several times. The synchronization mechanisms with *OPC, *OPC? and *WAI remain completely unaffected.

The measurement ends when a particular number of measurement points has been recorded (see `[SENSe:]SWEep:POINts` on page 587).

Performing gated measurements turns the squelch off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `SWE:EGAT ON`
Switches on the external gate mode.
`SWE:EGAT:TYPE EDGE`
Switches on the edge-triggered mode.
`SWE:EGAT:HOLD 100US`
Sets the gate delay to 100 µs.
`SWE:EGAT:LEN 500US`
Sets the gate opening time to 500 µs.
`INIT;*WAI`
Starts a sweep and waits for its end.

[SENSe:]SWEep:EGATe:HOLDoff <DelayTime>

This command defines the delay time between the gate signal and the continuation of the measurement.

Note: If you perform gated measurements in combination with the IF Power trigger, the R&S FSWP ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q mode measurements.

Parameters:
<DelayTime> Range: 0 s to 30 s
*RST: 0 s

Example: `SWE:EGAT:HOLD 100us`

Manual operation: See "Gate Delay" on page 285

[SENSe:]SWEep:EGATe:LENGth <GateLength>

This command defines the gate length.

Parameters:
<GateLength> Range: 125 ns to 30 s
*RST: 400µs

Example: `SWE:EGAT:LENG 10ms`

Manual operation: See "Gate Length" on page 285

[SENSe:]SWEep:EGATe:POLarity <Polarity>

This command selects the polarity of an external gate signal.

The setting applies both to the edge of an edge-triggered signal and the level of a level-triggered signal.

Parameters:
<Polarity> POSitive | NEGative
*RST: POSitive

Example: `SWE:EGAT:POL POS`

Manual operation: See "Slope" on page 283

[SENSe:]SWEep:EGATe:SOURce <Source>

This command selects the signal source for gated measurements.

If an IF power signal is used, the gate is opened as soon as a signal at > -20 dBm is detected within the IF path bandwidth (10 MHz).

For more information see "Trigger Source" on page 279.

Parameters:
<Source> EXTernal | EXT2 | EXT3 | IFPower | IQPower | VIDeo | RFPower | PSEN
*RST: IFPower

Example: `SWE:EGAT:SOUR IFP`
Switches the gate source to IF power.

Manual operation: See "Trigger Source" on page 279
See "Video" on page 280
See "IF Power" on page 280
See "RF Power" on page 281
See "Power Sensor" on page 281

[SENSe:]SWEep:EGATe:TYPE <Type>

This command selects the way gated measurements are triggered.

Parameters:

<Type>

LEVel
The trigger event for the gate to open is a particular power level. After the gate signal has been detected, the gate remains open until the signal disappears.
Note: If you perform gated measurements in combination with the IF Power trigger, the R&S FSWP ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q mode measurements.

EDGE
The trigger event for the gate to open is the detection of the signal edge.
After the gate signal has been detected, the gate remains open until the gate length is over.

*RST: EDGE

Example: `SWE:EGAT:TYPE EDGE`

Manual operation: See "Gate Mode" on page 285

5.7.7.3 Configuring Trigger Output

Commands to configure the trigger output described elsewhere:

- `OUTPut:TRIGger<port>:DIRection` on page 567
- `OUTPut:TRIGger<port>:LEVel` on page 567
- `OUTPut:TRIGger<port>:OTYPe` on page 567
- `OUTPut:TRIGger<port>:PULSe:IMMediate` on page 568
- `OUTPut:TRIGger<port>:PULSe:LENGth` on page 568

5.7.8 Automatic Configuration

[SENSe:]ADJust:ALL....597
[SENSe:]ADJust:CONFigure:DURation....597
[SENSe:]ADJust:CONFigure:DURation:MODE....597
[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer....598
[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer....598

[SENSe:]ADJust:CONFigure:TRIG....599
[SENSe:]ADJust:FREQuency....599
[SENSe:]ADJust:LEVel....599

[SENSe:]ADJust:ALL

This command initiates a measurement to determine and set the ideal settings for the current task automatically (only once for the current measurement).

This includes:

- Center frequency
- Reference level

Example: `ADJ:ALL`

Usage: Event

Manual operation: See "Adjusting all Determinable Settings Automatically (Auto All)" on page 289

[SENSe:]ADJust:CONFigure:DURation <Duration>

In order to determine the ideal reference level, the R&S FSWP performs a measurement on the current input data. This command defines the length of the measurement if `[SENSe:]ADJust:CONFigure:DURation:MODE` is set to `MANual`.

Parameters:

<Duration> Numeric value in seconds

Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

Example: `ADJ:CONF:DUR:MODE MAN`
Selects manual definition of the measurement length.
`ADJ:CONF:LEV:DUR 5ms`
Length of the measurement is 5 ms.

Manual operation: See "Changing the Automatic Measurement Time (Meastime Manual)" on page 290

[SENSe:]ADJust:CONFigure:DURation:MODE <Mode>

In order to determine the ideal reference level, the R&S FSWP performs a measurement on the current input data. This command selects the way the R&S FSWP determines the length of the measurement .

Parameters:

<Mode>

AUTO
The R&S FSWP determines the measurement length automatically according to the current input data.

MANual
The R&S FSWP uses the measurement length defined by `[SENSe:]ADJust:CONFigure:DURation` on page 597.

*RST: AUTO

Manual operation: See "Resetting the Automatic Measurement Time (Meastime Auto)" on page 290
See "Changing the Automatic Measurement Time (Meastime Manual)" on page 290

[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer <Threshold>

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 599 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold>

Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:LOW 2`
For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level falls below 18 dBm.

Manual operation: See "Lower Level Hysteresis" on page 290

[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer <Threshold>

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 599 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold>

Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:UPP 2`

Example: For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level rises above 22 dBm.

Manual operation: See "Upper Level Hysteresis" on page 290

[SENSe:]ADJust:CONFigure:TRIG <State>

Defines the behaviour of the measurement when adjusting a setting automatically (using `SENS:ADJ:LEV ON`, for example).

See "Adjusting settings automatically during triggered measurements" on page 289.

Parameters:

<State>

ON | 1
The measurement for automatic adjustment waits for the trigger.

OFF | 0
The measurement for automatic adjustment is performed immediately, without waiting for a trigger.

*RST: 1

[SENSe:]ADJust:FREQuency

This command sets the center frequency to the frequency with the highest signal level in the current frequency range.

Example: `ADJ:FREQ`

Usage: Event

Manual operation: See "Adjusting the Center Frequency Automatically (Auto Freq)" on page 289

[SENSe:]ADJust:LEVel

This command initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S FSWP or limiting the dynamic range by an S/N ratio that is too small.

Example: `ADJ:LEV`

Usage: Event

Manual operation: See "Setting the Reference Level Automatically (Auto Level)" on page 251

5.7.9 Transducer

MMEMory:SELect[:ITEM]:TRANsducer:ALL....600
[SENSe:]CORRection:TRANsducer:ADJust:RLEVel[:STATe]....600
[SENSe:]CORRection:TRANsducer:COMMent....600
[SENSe:]CORRection:TRANsducer:DATA....600
[SENSe:]CORRection:TRANsducer:DELete....601

[SENSe:]CORRection:TRANsducer:SCALing....601
[SENSe:]CORRection:TRANsducer:SELect....601
[SENSe:]CORRection:TRANsducer:UNIT....602
[SENSe:]CORRection:TRANsducer[:STATe]....602

MMEMory:SELect[:ITEM]:TRANsducer:ALL <State>

This command includes or excludes transducer factors when storing or loading a configuration file.

The command is available in the optional Spectrum application.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `MMEM:SEL:TRAN:ALL ON`

Manual operation: See "Save" on page 297

[SENSe:]CORRection:TRANsducer:ADJust:RLEVel[:STATe] <State>

This command turns an automatic adjustment of the reference level to the transducer on and off.

Before you can use the command, you have to select and turn on a transducer.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Adjusting the Reference Level" on page 294

[SENSe:]CORRection:TRANsducer:COMMent <Comment>

This command defines the comment for the selected transducer factor.

Before you can use the command, you have to select and turn on a transducer.

Parameters:
<Comment> *RST: (empty comment)

Manual operation: See "Comment" on page 296

[SENSe:]CORRection:TRANsducer:DATA
<Frequency>,<Level>[,<Frequency>,<Level>]

This command configures transducer factors for specific trace points. A set of transducer factors defines an interpolated transducer line and can be stored on the instrument.

For details see chapter 3.8.1, "Basics on Transducer Factors", on page 291.

Parameters:

<Frequency> The unit for <Frequency> is Hz, which may or may not be omitted. Frequencies have to be sorted in ascending order.

<Level> The unit for <Level> depends on `[SENSe:]CORRection:TRANsducer:UNIT`.

Example:

```
SENSe1:CORRection:TRANsducer:UNIT 'DB'
// Frequency Span 0 Hz to 4 Ghz
SENSe1:CORRection:TRANsducer:DATA 0,8,2e6,5,4GHz,3
```

Creates the transducer points:

Manual operation: See "Data points" on page 297

Frequency	Level
0 Hz	8 dB
2 GHz	5 dB
4 GHz	3 dB

[SENSe:]CORRection:TRANsducer:DELete

This command deletes the currently selected transducer factor.

Before you can use the command, you have to select a transducer.

Example:

```
CORR:TRAN:DEL
```

Usage: Event

Manual operation: See "Delete Line" on page 295

[SENSe:]CORRection:TRANsducer:SCALing <ScalingType>

This command selects the frequency scaling of the transducer factor.

Parameters:

<ScalingType> LINear | LOGarithmic

*RST: LINear

Manual operation: See "X-Axis Scaling" on page 297

[SENSe:]CORRection:TRANsducer:SELect <Name>

This command selects a transducer factor.

Parameters:

<Name> String containing the name of the transducer factor.
If the name does not exist yet, the R&S FSWP creates a transducer factor by that name.

Example:

```
CORR:TRAN:SEL 'FACTOR1'
```

Manual operation: See "Activating/Deactivating" on page 294
See "Create New Line" on page 295
See "Name" on page 296

[SENSe:]CORRection:TRANsducer:UNIT <Unit>

This command selects the unit of the transducer factor.

Before you can use the command, you have to select and turn on a transducer.

Parameters:
<Unit> string as defined in table below
*RST: DB

Example: `CORR:TRAN:UNIT 'DBUV'`

Manual operation: See "Unit" on page 296

String	Unit
'DB'	dB
'DBM'	dBm
'DBMV'	dBmV
'DBUV'	dBµV
'DBUV/M'	dBµV/m
'DBUA'	dBµA
'DBUA/M'	dBµA/m
'DBPW'	dBpW
'DBPT'	dBpT

[SENSe:]CORRection:TRANsducer[:STATe] <State>

This command turns the selected transducer factor on or off.

Before you can use the command, you have to select a transducer.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Activating/Deactivating" on page 294

5.8 Common Analysis and Display Functions

- Zoom....603
- Remote Commands to Configure Traces....605
- Marker Usage....622
- Lines....660

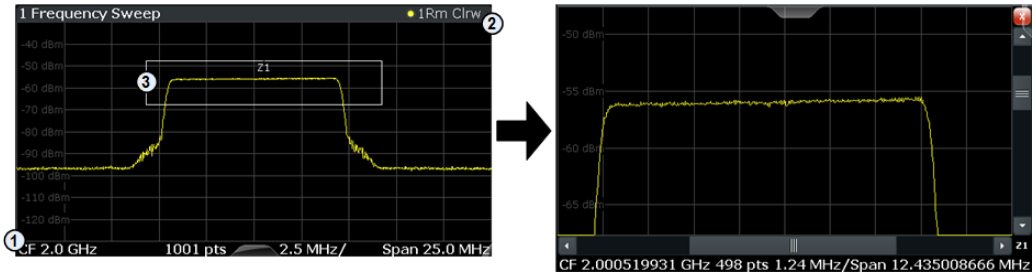
5.8.1 Zoom

DISPlay[:WINDow<n>]:ZOOM:AREA....603
DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA....603
DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe....604
DISPlay[:WINDow<n>]:ZOOM:STATe....604

DISPlay[:WINDow<n>]:ZOOM:AREA <x1>,<y1>,<x2>,<y2>

This command defines the zoom area.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)
2 = end point of system (x2 = 100, y2= 100)
3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Parameters:

<x1>,<y1>,
<x2>,<y2>

Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

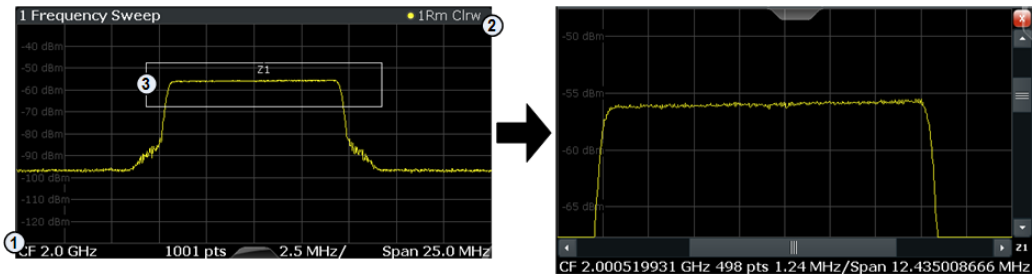
Range: 0 to 100
Default unit: PCT

Manual operation: See "Single Zoom" on page 310

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA <x1>,<y1>,<x2>,<y2>

This command defines the zoom area for a multiple zoom.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)
2 = end point of system (x2 = 100, y2= 100)
3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Suffix:

<zoom> 1...4
Selects the zoom window.

Parameters:

<x1>,<y1>,
<x2>,<y2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100
Default unit: PCT

Manual operation: See "Multiple Zoom" on page 310

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe <State>

This command turns the mutliple zoom on and off.

Suffix:

<zoom> 1...4
Selects the zoom window.
If you turn off one of the zoom windows, all subsequent zoom windows move up one position.

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "Multiple Zoom" on page 310
See "Restore Original Display" on page 310
See "Deactivating Zoom (Selection mode)" on page 310

DISPlay[:WINDow<n>]:ZOOM:STATe <State>

This command turns the zoom on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DISP:ZOOM ON`
Activates the zoom mode.

Manual operation: See "Single Zoom" on page 310
See "Restore Original Display" on page 310
See "Deactivating Zoom (Selection mode)" on page 310

5.8.2 Remote Commands to Configure Traces

- Getting Trace Data....605
- Configuring Traces....608
- Performing Trace Mathematics....612
- Exporting Traces....614
- Configuring Spectrograms....616

5.8.2.1 Getting Trace Data

MMEMory:STORe<n>:TRACe....605
TRACe<n>[:DATA]....606
TRACe<n>[:DATA]:MEMory?....607
TRACe<n>[:DATA]:X?....608

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

This command exports trace data from the specified window to an ASCII file.

For details on the file format see chapter 4.3.6, "Reference: ASCII File Export Format", on page 343.

Secure User Mode

In secure user mode, settings that are to be stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error may occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSWP User Manual..

Parameters:

<Trace> Number of the trace to be stored
(This parameter is ignored if the option "Export all Traces and all Table Results" is activated in the Export configuration settings, see `FORMat:DEXPort:TRACes` on page 616).

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 3,'C:\TEST.ASC'`
Stores trace 3 from window 1 in the file `TEST.ASC`.

Usage: SCPI confirmed

Manual operation: See "Export Trace to ASCII File" on page 331

TRACe<n>[:DATA] <Trace>,<Data> | <ResultType>

This command queries current trace data and measurement results.

If you use it as a setting command, it transfers trace data from an external source to the R&S FSWP.

The data format depends on `FORMat[:DATA]`.

Parameters:

<Trace> Selects the trace to write the data to.

TRACE1 | ... | TRACE6

<Data> Contains the data to transfer.

Query parameters:

<ResultType> Selects the type of result to be returned.

TRACE1 | ... | TRACE6
Returns the trace data for the corresponding trace.
For details see table 5-5.

LIST
Returns the results of the peak list evaluation for Spurious Emission and Spectrum Emission Mask measurements.
For SEM measurements, one peak per range is returned.
For spurious emission measurements, the number of peaks returned for each measurement range is defined by the "Peaks per Range" parameter (see `CALCulate<n>:PEAKsearch:SUBRanges` on page 494), regardless of the "Details" setting.
For details see table 5-6.

SPURious
Returns the peak list of Spurious Emission measurements.

SPECtrogram | SGRam
Returns the results of the spectrogram result display.
For details see table 5-7.

Return values:

<TraceData> For more information see tables below.

Example:
```
TRAC TRACE1,+A$
```
Transfers trace data ('+A$') to trace 1.

Example:
```
TRAC? TRACE3
```
Queries the data of trace 3.

Usage: SCPI confirmed

Manual operation: See "Spectrum Emission Mask" on page 15
See "Spurious Emissions" on page 15
See "List Evaluation (Result Summary) State" on page 128
See "List Evaluation State" on page 150

Table 5-5: Return values for TRACE1 to TRACE6 parameter

The trace data consists of a list of power levels that have been measured. The number of power levels in the list depends on the currently selected number of sweep points. The unit depends on the measurement and on the unit you have currently set. If you are measuring with the auto peak detector, the command returns positive peak values only. (To retrieve negative peak values, define a second trace with a negative peak detector.) For SEM or Spurious Emission measurement results, the x-values should be queried as well, as they are not equi-distant (see `TRACe<n>[:DATA]:X?` on page 608).

Table 5-6: Return values for LIST parameter

For each peak, the command returns 11 values in the following order: <No>,<StartFreq>,<StopFreq>,<RBW>,<PeakFreq>,<PowerAbs>,<PowerRel>,<PowerDelta>,<LimitCheck>,<Unused1>,<Unused2> • <No>: range number • <StartFreq>,<StopFreq>: start and stop frequency of the range • <RBW>: resolution bandwidth • <PeakFreq>: frequency of the peak in a range • <PowerAbs>: absolute power of the peak in dBm • <PowerRel>: power of the peak in relation to the channel power in dBc • <PowerDelta>: distance from the peak to the limit line in dB, positive values indicate a failed limit check • <LimitCheck>: state of the limit check (0 = PASS, 1 = FAIL) • <Unused1>,<Unused2>: reserved (0.0)

Table 5-7: Return values for SPECtrogram parameter

For every frame in the spectrogram, the command returns the power levels that have been measured, one for each sweep point. The number of frames depends on the size of the history depth. The power level depends on the unit you have currently set.

TRACe<n>[:DATA]:MEMory? <Trace>,<OffsSwPoint>,<NoOfSwPoints>

This command queries the previously captured trace data for the specified trace from the memory. As an offset and number of sweep points to be retrieved can be specified, the trace data can be retrieved in smaller portions, making the command faster than the `TRAC:DATA?` command. This is useful if only specific parts of the trace data are of interest.

If no parameters are specified with the command, the entire trace data is retrieved; in this case, the command is identical to `TRAC:DATA? TRACE1`

For details on the returned values see the TRAC:DATA? <TRACE...> command.

Query parameters:

<Trace> TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6

<OffsSwPoint> The offset in sweep points related to the start of the measurement at which data retrieval is to start.

<NoOfSwPoints> Number of sweep points to be retrieved from the trace.

Example: `TRAC:DATA:MEM? TRACE1,25,100`
Retrieves 100 sweep points from trace 1, starting at sweep point 25.

Usage: Query only

TRACe<n>[:DATA]:X? <TraceNumber>

This command queries the horizontal trace data for each sweep point in the specified window, for example the frequency in frequency domain or the time in time domain measurements.

Query parameters:

<TraceNumber> Trace number.
TRACE1 | ... | TRACE6

Example: `TRAC3:X? TRACE1`
Returns the x-values for trace 1 in window 3.

Usage: Query only

Manual operation: See "Spectrum Emission Mask" on page 15

5.8.2.2 Configuring Traces

[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO....608
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]....608
DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture....609
DISPlay[:WINDow<n>]:TRACe<t>:MODE....609
DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONtinuous....610
DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe]....611
DISPlay[:WINDow<n>]:TRACe<t>[:STATe]....611
DISPlay[:WINDow<n>]:TRACe:X:SPACing....611
DISPlay[:WINDow<n>]:TRACe<t>[:STATe]....612
TRACe<n>:COPY....612

[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO <State>

This command couples and decouples the detector to the trace mode.

Parameters:

<State> ON | OFF | 0 | 1
*RST: 1

Example: `DET:AUTO OFF`
The selection of the detector is not coupled to the trace mode.

Manual operation: See "Detector" on page 328

[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion] <Detector>

Defines the trace detector to be used for trace analysis.

For details see chapter 4.3.1.1, "Mapping Samples to measurement Points with the Trace Detector", on page 313.

Parameters:

<Detector>

APEak
Autopeak

NEGative
Negative peak

POSitive
Positive peak

QPEak
Quasipeak (CISPR filter only)

SAMPle
First value detected per trace point

RMS
RMS value

AVERage
Average

*RST: APEak

Example: `DET POS`
Sets the detector to "positive peak".

Manual operation: See "Detector" on page 328

DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture <Percentage>

This command defines the degree (aperture) of the trace smoothing, if `DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe] TRUE`.

Parameters:

<Percentage>

Range: 1 to 50
*RST: 2
Default unit: PCT

Example: `DISP3:TRAC2:SMO:APER 5`
Defines an aperture of 5% for trace 2 in window 3

Manual operation: See "Smoothing" on page 328

DISPlay[:WINDow<n>]:TRACe<t>:MODE <Mode>

This command selects the trace mode.

In case of max hold, min hold or average trace mode, you can set the number of single measurements with `[SENSe:]SWEep:COUNt`. Note that synchronization to the end of the measurement is possible only in single sweep mode.

Parameters:

<Mode>

WRITe
Overwrite mode: the trace is overwritten by each sweep. This is the default setting.

AVERage
The average is formed over several sweeps. The "Sweep/Average Count" determines the number of averaging procedures.

MAXHold
The maximum value is determined over several sweeps and displayed. The R&S FSWP saves the sweep result in the trace memory only if the new value is greater than the previous one.

MINHold
The minimum value is determined from several measurements and displayed. The R&S FSWP saves the sweep result in the trace memory only if the new value is lower than the previous one.

VIEW
The current contents of the trace memory are frozen and displayed.

BLANk
Hides the selected trace.

*RST: Trace 1: WRITe, Trace 2-6: BLANk

Example:

```
INIT:CONT OFF
```
Switching to single sweep mode.
```
SWE:COUN 16
```
Sets the number of measurements to 16.
```
DISP:TRAC3:MODE WRIT
```
Selects clear/write mode for trace 3.
```
INIT;*WAI
```
Starts the measurement and waits for the end of the measurement.

Manual operation: See "Trace Mode" on page 327

DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONtinuous <State>

This command turns an automatic reset of a trace on and off after a parameter has changed.

The reset works for trace modes min hold, max hold and average.

Note that the command has no effect if critical parameters like the span have been changed to avoid invalid measurement results

Parameters:

<State>

ON
The automatic reset is off.

OFF
The automatic reset is on.

*RST: OFF

Example: `DISP:WIND:TRAC3:MODE:HCON ON`
Switches off the reset function.

Manual operation: See "Hold" on page 328

DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe] <State>

This command turns trace smoothing for a particular trace on and off.

If enabled, the trace is smoothed by the value specified using `DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture` on page 609.

For more information see chapter 4.3.1.6, "Trace Smoothing", on page 319.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DISP3:TRAC2:SMO ON`
Turns on trace smoothing for trace 2 in window 3

Usage: SCPI confirmed

Manual operation: See "Smoothing" on page 328

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] <State>

This command turns a trace on and off.

Parameters:

<State> ON | OFF

*RST: Trace 1: ON, Trace 2-6: OFF

Example: `DISP:TRAC3 ON`

Usage: SCPI confirmed

DISPlay[:WINDow<n>]:TRACe:X:SPACing <ScalingType>

This command selects the scaling of the x-axis.

Parameters:

<ScalingType>

LOGarithmic
Logarithmic scaling.

LINear
Linear scaling.

*RST: LINear

Example:
```
DISP:TRAC:X:SPAC LOG
```

Manual operation: See "Frequency Axis Scaling" on page 242

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] <State>

This command turns a trace on and off.

The measurement continues in the background.

Parameters:

<State>

ON | OFF | 0 | 1

*RST: 1 for TRACe1, 0 for TRACe 2 to 6

Example:
```
DISP:TRAC3 ON
```

Usage: SCPI confirmed

Manual operation: See "Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)" on page 330

TRACe<n>:COPY <TraceNumber>, <TraceNumber>

This command copies data from one trace to another.

Parameters:

<TraceNumber>, <TraceNumber>

TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6
The first parameter is the destination trace, the second parameter is the source.
(Note the 'e' in the parameter is required!)

Example:
```
TRAC:COPY TRACE1,TRACE2
```
Copies the data from trace 2 to trace 1.

Usage: SCPI confirmed

5.8.2.3 Performing Trace Mathematics

CALCulate<n>:MATH[:EXPression][:DEFine] 612
CALCulate<n>:MATH:MODE 613
CALCulate<n>:MATH:POSition 613
CALCulate<n>:MATH:STATe 614

CALCulate<n>:MATH[:EXPression][:DEFine] <Expression>

This command selects the mathematical expression for trace mathematics.

Before you can use the command, you have to turn trace mathematics on.

Parameters:

<Expression>

(TRACE1-TRACE2)
Subtracts trace 2 from trace 1.

(TRACE1-TRACE3)
Subtracts trace 3 from trace 1.

(TRACE1-TRACE4)
Subtracts trace 4 from trace 1.

(TRACE1-TRACE5)
Subtracts trace 5 from trace 1.

(TRACE1-TRACE6)
Subtracts trace 6 from trace 1.

Example:

```
CALC:MATH:STAT ON
```
Turns trace mathematics on.
```
CALC:MATH:EXPR:DEF (TRACE1-TRACE3)
```
Subtracts trace 3 from trace 1.

Usage: SCPI confirmed

Manual operation: See "Trace Math Function" on page 332

CALCulate<n>:MATH:MODE <Mode>

This command selects the way the R&S FSWP calculates trace mathematics.

Parameters:

<Mode>

For more information on the way each mode works see Trace Math Mode.

LINear
Linear calculation.

LOGarithmic
Logarithmic calculation.

POWer
Linear power calculation.

*RST: LOGarithmic

Example:

```
CALC:MATH:MODE LIN
```
Selects linear calculation.

Manual operation: See "Trace Math Mode" on page 333

CALCulate<n>:MATH:POSition <Position>

This command defines the position of the trace resulting from the mathematical operation.

Parameters:

<Position> Vertical position of the trace in % of the height of the diagram area.
100 PCT corresponds to the upper diagram border.

Range: -100 to 200
*RST: 50
Default unit: PCT

Example: `CALC:MATH:POS 100`
Moves the trace to the top of the diagram area.

Manual operation: See "Trace Math Position" on page 333

CALCulate<n>:MATH:STATe <State>

This command turns the trace mathematics on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MATH:STAT ON`
Turns on trace mathematics.

Usage: SCPI confirmed

Manual operation: See "Trace Math Function" on page 332
See "Trace Math Off" on page 332

5.8.2.4 Exporting Traces

FORMat[:DATA] 614
FORMat:DEXPort:DSEParator 615
FORMat:DEXPort:HEADer 615
FORMat:DEXPort:TRACes 616

FORMat[:DATA] <Format>

This command selects the data format that is used for transmission of trace data from the R&S FSWP to the controlling computer.

Note that the command has no effect for data that you send to the R&S FSWP. The R&S FSWP automatically recognizes the data it receives, regardless of the format.

For details on data formats see chapter 4.3.7, "Formats for Returned Values: ASCII Format and Binary Format", on page 347.

Parameters:

<Format>

ASCii
ASCii format, separated by commas.
This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats may be.

REAL,32
32-bit IEEE 754 floating-point numbers in the "definite length block format".
The format setting `REAL` is used for the binary transmission of trace data.
For I/Q data, 8 bytes per sample are returned for this format setting.

*RST: ASCII

Example: `FORM REAL,32`

Usage: SCPI confirmed

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator>

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator. Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

Manual operation: See "Saving the Result Summary (Evaluation List) to a File" on page 128
See "Saving the Evaluation List" on page 151
See "Decimal Separator" on page 331
See "Exporting the Peak List" on page 378

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

See chapter 4.3.6, "Reference: ASCII File Export Format", on page 343 for details.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Usage: SCPI confirmed

Manual operation: See "Include Instrument Measurement Settings" on page 331

FORMat:DEXPort:TRACes <Selection>

This command selects the data to be included in a data export file (see `MMEMory:STORe<n>:TRACe` on page 605).

For details on exporting data see chapter 4.3.2.2, "Trace / Data Export Configuration", on page 330.

Parameters:

<Selection>

SINGle
Only a single trace is selected for export, namely the one specified by the `MMEMory:STORe<n>:TRACe` command.

ALL
Selects all active traces and result tables (e.g. Result Summary, marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the `MMEMory:STORe<n>:TRACe` command is ignored.

*RST: SINGle

Usage: SCPI confirmed

Manual operation: See "Export all Traces and all Table Results" on page 331

5.8.2.5 Configuring Spectrograms

CALCulate<n>:SGRam:CLEar[:IMMediate] 617
CALCulate<n>:SPECtrogram:CLEar[:IMMediate] 617
CALCulate<n>:SGRam:CONT 617
CALCulate<n>:SPECtrogram:CONT 617
CALCulate<n>:SGRam:FRAMe:COUNt 617
CALCulate<n>:SPECtrogram:FRAMe:COUNt 617
CALCulate<n>:SGRam:FRAMe:SELect 618
CALCulate<n>:SPECtrogram:FRAMe:SELect 618
CALCulate<n>:SGRam:HDEPth 618
CALCulate<n>:SPECtrogram:HDEPth 618
CALCulate<n>:SGRam:TSTamp:DATA? 619
CALCulate<n>:SPECtrogram:TSTamp:DATA? 619
CALCulate<n>:SGRam:TSTamp[:STATe] 619
CALCulate<n>:SPECtrogram:TSTamp[:STATe] 619
CALCulate<n>:SGRam[:STATe] 620
CALCulate<n>:SPECtrogram[:STATe] 620
DISPlay[:WINDow<n>]:SGRam:COLor:DEFault 620
DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault 620
DISPlay[:WINDow<n>]:SGRam:COLor:LOWer 620
DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer 620
DISPlay[:WINDow<n>]:SGRam:COLor:SHAPe 621

DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe....621
DISPlay[:WINDow<n>]:SGRam:COLor:UPPer....621
DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer....621
DISPlay[:WINDow<n>]:SGRam:COLor[:STYLe]....621
DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe]....621
MMEMory:STORe<n>:SPECtrogram....622

CALCulate<n>:SGRam:CLEar[:IMMediate]
CALCulate<n>:SPECtrogram:CLEar[:IMMediate]

This command resets the spectrogram and clears the history buffer.

(<n> is irrelevant.)

Example: `CALC:SGR:CLE`
Resets the result display and clears the memory.

Usage: Event

Manual operation: See "Clear Spectrogram" on page 269

CALCulate<n>:SGRam:CONT <State>
CALCulate<n>:SPECtrogram:CONT <State>

This command determines whether the results of the last measurement are deleted before starting a new measurement in single sweep mode.

(<n> is irrelevant.)

Parameters:
<State> ON | OFF
*RST: OFF

Example: `INIT:CONT OFF`
Selects single sweep mode.
`INIT;*WAI`
Starts the sweep and waits for the end of the sweep.
`CALC:SGR:CONT ON`
Repeats the single sweep measurement without deleting the results of the last measurement.

Manual operation: See "Single Sweep/ RUN SINGLE" on page 267
See "Continue Frame" on page 268

CALCulate<n>:SGRam:FRAMe:COUNt <Frames>
CALCulate<n>:SPECtrogram:FRAMe:COUNt <Frames>

This command defines the number of frames to be recorded in a single sweep.

(<n> is irrelevant.)

Parameters:

<Frames> The maximum number of frames depends on the history depth.

Range: 1 to history depth
Increment: 1
*RST: 1

Example: `INIT:CONT OFF`
Selects single sweep mode.
`CALC:SGR:FRAM:COUN 200`
Sets the number of frames to 200.

Manual operation: See "Frame Count" on page 269

CALCulate<n>:SGRam:FRAMe:SELect <Frame> | <Time>
CALCulate<n>:SPECtrogram:FRAMe:SELect <Frame> | <Time>

This command selects a specific frame for further analysis.

(<n> is irrelevant.)

The command is available if no measurement is running or after a single sweep has ended.

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example: `INIT:CONT OFF`
Stop the continuous sweep.
`CALC:SGR:FRAM:SEL -25`
Selects frame number -25.

Manual operation: See "Selecting a frame to display" on page 268

CALCulate<n>:SGRam:HDEPth <History>
CALCulate<n>:SPECtrogram:HDEPth <History>

This command defines the number of frames to be stored in the R&S FSWP memory.

(<n> is irrelevant.)

Parameters:

<History> The maximum number of frames depends on the number of sweep points.

Range: 781 to 20000
Increment: 1
*RST: 3000

Example: `CALC:SGR:SPEC 1500`
Sets the history depth to 1500.

Manual operation: See "History Depth" on page 334

CALCulate<n>:SGRam:TSTamp:DATA? <Frames>
CALCulate<n>:SPECtrogram:TSTamp:DATA? <Frames>

This command queries the starting time of the frames.

(<n> is irrelevant.)

The return values consist of four values for each frame. If the Spectrogram is empty, the command returns '0,0,0,0'. The times are given as delta values, which simplifies evaluating relative results; however, you can also calculate the absolute date and time as displayed on the screen.

The frame results themselves are returned with `TRAC:DATA? SGR`

See `TRACe<n>[:DATA]` on page 606.

Query parameters:

<Frames>
CURRent
Returns the starting time of the current frame.

ALL
Returns the starting time for all frames. The results are sorted in descending order, beginning with the current frame.

Return values:

<Seconds> Number of seconds that have passed since 01.01.1970 till the frame start

<Nanoseconds> Number of nanoseconds that have passed *in addition to the <Seconds>* since 01.01.1970 till the frame start.

<Reserved> The third and fourth value are reserved for future uses.

Example: `CALC:SGR:TST ON`
Activates the time stamp.
`CALC:SGR:TST:DATA? ALL`
Returns the starting times of all frames sorted in a descending order.

Usage: Query only

Manual operation: See "Timestamp" on page 335

CALCulate<n>:SGRam:TSTamp[:STATe] <State>
CALCulate<n>:SPECtrogram:TSTamp[:STATe] <State>

This command activates and deactivates the time stamp.

(<n> is irrelevant.)

If the time stamp is active, some commands do not address frames as numbers, but as (relative) time values:

- CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe on page 624
- CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe on page 626
- CALCulate<n>:SPECtrogram:FRAMe:SELect on page 618

Parameters:
<State> ON | OFF
*RST: OFF

Example: CALC:SGR:TST ON
Activates the time stamp.

Manual operation: See "Timestamp" on page 335

CALCulate<n>:SGRam[:STATe] <State>
CALCulate<n>:SPECtrogram[:STATe] <State>

This command turns the spectrogram on and off.

(<n> is irrelevant.)

Parameters:
<State> ON | OFF
*RST: OFF

Example: CALC:SGR ON
Activates the Spectrogram result display.

Manual operation: See "State" on page 334

DISPlay[:WINDow<n>]:SGRam:COLor:DEFault
DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault

This command restores the original color map.

Usage: Event

Manual operation: See "Set to Default" on page 337

DISPlay[:WINDow<n>]:SGRam:COLor:LOWer <Percentage>
DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer <Percentage>

This command defines the starting point of the color map.

Parameters:
<Percentage> Statistical frequency percentage.
Range: 0 to 66
*RST: 0
Default unit: %

Example: DISP:WIND:SGR:COL:LOW 10
Sets the start of the color map to 10%.

Manual operation: See "Start / Stop" on page 337

DISPlay[:WINDow<n>]:SGRam:COLor:SHAPe <Shape>
DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe <Shape>

This command defines the shape and focus of the color curve for the spectrogram result display.

Parameters:

<Shape> Shape of the color curve.

Range: -1 to 1
*RST: 0

Manual operation: See "Shape" on page 337

DISPlay[:WINDow<n>]:SGRam:COLor:UPPer <Percentage>
DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer <Percentage>

This command defines the end point of the color map.

Parameters:

<Percentage> Statistical frequency percentage.

Range: 0 to 66
*RST: 0
Default unit: %

Example: `DISP:WIND:SGR:COL:UPP 95`
Sets the start of the color map to 95%.

Manual operation: See "Start / Stop" on page 337

DISPlay[:WINDow<n>]:SGRam:COLor[:STYLe] <ColorScheme>
DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe] <ColorScheme>

This command selects the color scheme.

Parameters:

<ColorScheme>

HOT
Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.

COLD
Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.

RADar
Uses a color range from black over green to light turquoise with shades of green in between.

GRAYscale
Shows the results in shades of gray.

*RST: HOT

Example: `DISP:WIND:SPEC:COL GRAY`
Changes the color scheme of the spectrogram to black and white.

Manual operation: See "Hot/Cold/Radar/Grayscale" on page 337

MMEMory:STORe<n>:SPECtrogram <FileName>

This command exports spectrogram data to an ASCII file.

The file contains the data for every frame in the history buffer. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Note that, depending on the size of the history buffer, the process of exporting the data can take a while.

Parameters:

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:SGR 'Spectrogram'`
Copies the spectrogram data to a file.

Manual operation: See "Export Trace to ASCII File" on page 331

5.8.3 Marker Usage

- Individual Marker Setup 622
- General Marker Settings 627
- Marker Search 630
- Positioning Markers 633
- Retrieving Marker Positions 638
- Using Markers in Spectrograms 640
- Marker Functions 647

5.8.3.1 Individual Marker Setup

CALCulate<n>:DELTamarker<m>:AOFF 623
CALCulate<n>:DELTamarker<m>:LINK 623
CALCulate<n>:DELTamarker<m>:LINK:TO:MARKer<m> 623
CALCulate<n>:DELTamarker<m>:MODE 623
CALCulate<n>:DELTamarker<m>:MREF 624
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe 624
CALCulate<n>:DELTamarker<m>[:STATe] 624
CALCulate<n>:DELTamarker<m>:TRACe 625
CALCulate<n>:DELTamarker<m>:X 625
CALCulate<n>:MARKer<m>:AOFF 625
CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m> 626
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe 626
CALCulate<n>:MARKer<m>[:STATe] 626
CALCulate<n>:MARKer<m>:TRACe 627
CALCulate<n>:MARKer<m>:X 627

CALCulate<n>:DELTamarker<m>:AOFF

This command turns *all* delta markers off.

(<m> is irrelevant)

Example: `CALC:DELT:AOFF`
Turns all delta markers off.

Usage: Event

CALCulate<n>:DELTamarker<m>:LINK <State>

This command links delta marker <m> to marker 1.

If you change the horizontal position (x-value) of marker 1, delta marker <m> changes its horizontal position to the same value.

Tip: to link any marker to a different marker than marker 1, use the `CALCulate<n>:DELTamarker<m>:LINK:TO:MARKer<m>` or `CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m>` commands.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:DELT2:LINK ON`

Manual operation: See "Linking to Another Marker" on page 360

CALCulate<n>:DELTamarker<m>:LINK:TO:MARKer<m> <State>

This command links delta marker <m1> to any active normal marker <m2>.

If you change the horizontal position of marker <m2>, delta marker <m1> changes its horizontal position to the same value.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:DELT4:LINK:TO:MARK2 ON`
Links the delta marker 4 to the marker 2.

Manual operation: See "Linking to Another Marker" on page 360

CALCulate<n>:DELTamarker<m>:MODE <Mode>

This command defines whether the position of a delta marker is provided as an absolute value or relative to a reference marker (for *all* delta markers, <m> is irrelevant).

Note that when the position of a delta marker is *queried*, the result is always an absolute value (see `CALCulate<n>:DELTamarker<m>:X` on page 625)!

Parameters:

<Mode>

ABSolute
Delta marker position in absolute terms.

RELative
Delta marker position in relation to a reference marker.

*RST: RELative

Example:
```
CALC:DELT:MODE ABS
```
Absolute delta marker position.

CALCulate<n>:DELTamarker<m>:MREF <Reference>

This command selects a reference marker for a delta marker other than marker 1.

The reference may be another marker or the fixed reference.

Parameters:

<Reference>

FIXed
Selects the fixed reference as the reference.

Example:
```
CALC:DELT3:MREF 2
```
Specifies that the values of delta marker 3 are relative to marker 2.

Manual operation: See "Reference Marker" on page 360

CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe <Frame> | <Time>

This command positions a delta marker on a particular frame. The frame is relative to the position of marker 1.

The command is available for the spectrogram.

Parameters:

<Frame>
Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

<Time>
Selects a frame via its time stamp. Valid if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example:
```
CALC:DELT4:SGR:FRAM -20
```
Sets fourth deltamarker 20 frames below marker 1.
```
CALC:DELT4:SGR:FRAM 2 s
```
Sets fourth deltamarker 2 seconds above the position of marker 1.

Manual operation: See "Frame (Spectrogram only)" on page 360

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "Marker State" on page 359
See "Marker Type" on page 360

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Parameters:

<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.
The position is relative to the reference marker.
A query returns the absolute position of the delta marker.

Range: The value range and unit depend on the measurement and scale of the x-axis.

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

Manual operation: See "Marker 1/2/3/4" on page 186
See "Marker 1/2/3" on page 191
See "Marker Position (X-value)" on page 359

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers off.

Example: CALC:MARK:AOFF
Switches off all markers.

Usage: Event

Manual operation: See "All Markers Off" on page 361

CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m> <State>

This command links normal marker <m1> to any active normal marker <m2>.

If you change the horizontal position of marker <m2>, marker <m1> changes its horizontal position to the same value.

Parameters:

<State> ON | OFF
*RST: OFF

Example: CALC:MARK4:LINK:TO:MARK2 ON
Links marker 4 to marker 2.

Manual operation: See "Linking to Another Marker" on page 360

CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe <Frame> | <Time>

This command positions a marker on a particular frame.

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
The number is the (negative) distance to frame 0 in seconds.
The range depends on the history depth.

Example: CALC:MARK:SGR:FRAM -20
Sets the marker on the 20th frame before the present.
CALC:MARK2:SGR:FRAM -2s
Sets second marker on the frame 2 seconds ago.

Manual operation: See "Frame (Spectrogram only)" on page 360

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off. If the corresponding marker number is currently active as a deltamarker, it is turned into a normal marker.

Parameters:

<State> ON | OFF
*RST: OFF

Example: CALC:MARK3 ON
Switches on marker 3.

Manual operation: See "Marker State" on page 359
See "Marker Type" on page 360

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Parameters:
<Trace> **1 to 6**
Trace number the marker is assigned to.

Example: `CALC:MARK3:TRAC 2`
Assigns marker 3 to trace 2.

Manual operation: See "Assigning the Marker to a Trace" on page 361

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Parameters:
<Position> Numeric value that defines the marker position on the x-axis. The unit is either Hz (frequency domain) or s (time domain) or dB (statistics).

Range: The range depends on the current x-axis range.

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker 1/2/3/4" on page 186
See "Marker 1/2/3" on page 191
See "Marker Table" on page 302
See "Marker Peak List" on page 303
See "Marker Position (X-value)" on page 359

5.8.3.2 General Marker Settings

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK] 628
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X 628
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y 628
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y:OFFSet 629
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed[:STATe] 629

CALCulate<n>:MARKer<m>:X:SSIZe 629
DISPlay:MINFo[:STAT] 630
DISPlay:MTABle 630

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK]

This command moves the fixed reference marker to the peak power.

Example: `CALC:DELT:FUNC:FIX:RPO:MAX`
Sets the reference point level for delta markers to the peak of the selected trace.

Usage: Event

Manual operation: See "Defining a Fixed Reference" on page 362
See "Defining a Reference Point" on page 373

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X <RefPoint>

This command defines the horizontal position of the fixed delta marker reference point. The coordinates of the reference may be anywhere in the diagram.

Parameters:
<RefPoint> Numeric value that defines the horizontal position of the reference.
For frequency domain measurements, it is a frequency in Hz.
For time domain measurements, it is a point in time in s.
*RST: Fixed Reference: OFF

Example: `CALC:DELT:FUNC:FIX:RPO:X 128 MHz`
Sets the frequency reference to 128 MHz.

Manual operation: See "Defining a Fixed Reference" on page 362
See "Defining a Reference Point" on page 373

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y <RefPointLevel>

This command defines the vertical position of the fixed delta marker reference point. The coordinates of the reference may be anywhere in the diagram.

Parameters:
<RefPoint> Numeric value that defines the vertical position of the reference. The unit and value range is variable.
*RST: Fixed Reference: OFF

Example: `CALC:DELT:FUNC:FIX:RPO:Y -10dBm`
Sets the reference point level for delta markers to -10 dBm.

Manual operation: See "Defining a Fixed Reference" on page 362
See "Defining a Reference Point" on page 373

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y:OFFSet <Offset>

This command defines a level offset for the fixed delta marker reference point.

Parameters:

<Offset> Numeric value

*RST: 0
Default unit: dB

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed[:STATe] <State>

This command activates or deactivates a marker that defines a fixed reference point for relative marker analysis.

If necessary, the command activates a marker and positions it on the peak power.

Subsequently, you can change the coordinates of the fixed reference independent of the marker. The fixed reference is independent of the trace and is applied to all active delta markers.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT:FUNC:FIX ON`
Switches on the measurement with fixed reference value for all delta markers.
`CALC:DELT:FUNC:FIX:RPO:X 128 MHZ`
Sets the frequency reference to 128 MHz.
`CALC:DELT:FUNC:FIX:RPO:Y 30 DBM`
Sets the reference level to +30 dBm.

Manual operation: See "Defining a Fixed Reference" on page 362

CALCulate<n>:MARKer<m>:X:SSIZe <StepSize>

This command selects the marker step size mode for *all* markers in *all* windows (<m>, <n> are irrelevant).

The step size defines the distance the marker moves when you move it with the rotary knob.

It therefore takes effect in manual operation only.

Parameters:

<StepSize> **STANdard**
the marker moves from one pixel to the next

POINts
the marker moves from one sweep point to the next

*RST: POINts

Example: `CALC:MARK:X:SSIZ STAN`
Sets the marker step size to one pixel.

Manual operation: See "Marker Stepsize" on page 362

DISPlay:MINFo[:STAT] <DisplayMode>

This command turns the marker information in all diagrams on and off.

Parameters:

<DisplayMode>

ON
Displays the marker information in the diagrams.

OFF
Hides the marker information in the diagrams.

*RST: ON

Example: `DISP:MINF OFF`
Hides the marker information.

Manual operation: See "Marker Info" on page 362

DISPlay:MTABle <DisplayMode>

This command turns the marker table on and off.

Parameters:

<DisplayMode>

ON
Turns the marker table on.

OFF
Turns the marker table off.

AUTO
Turns the marker table on if 3 or more markers are active.

*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual operation: See "Marker Table Display" on page 362

5.8.3.3 Marker Search

CALCulate<n>:MARKer<m>:LOEXclude 631
CALCulate<n>:MARKer<m>:PEXCursion 631
CALCulate<n>:MARKer<m>:X:SLIMits:LEFT 631
CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT 632
CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe] 632
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] 632
CALCulate<n>:THReshold 633
CALCulate<n>:THReshold:STATe 633

CALCulate<n>:MARKer<m>:LOEXclude <State>

This command turns the suppression of the local oscillator during automatic marker positioning on and off (for *all* markers in *all* windows; <m>, <n> are irrelevant).

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example: `CALC:MARK:LOEX ON`

Manual operation: See "Exclude LO" on page 364

CALCulate<n>:MARKer<m>:PEXCursion <Excursion>

This command defines the peak excursion (for *all* markers in *all* windows; <m>, <n> are irrelevant).

The peak excursion sets the requirements for a peak to be detected during a peak search.

The unit depends on the measurement.

Application/Result display	Unit
Spectrum	dB

Parameters:

<Excursion> The excursion is the distance to a trace maximum that must be attained before a new maximum is recognized, or the distance to a trace minimum that must be attained before a new minimum is recognized

*RST: 6 dB

Example: `CALC:MARK:PEXC 10dB`
Defines peak excursion as 10 dB.

Manual operation: See "Peak Excursion" on page 365

CALCulate<n>:MARKer<m>:X:SLIMits:LEFT <SearchLimit>

This command defines the left limit of the marker search range for *all* markers in *all* windows (<m>, <n> are irrelevant).

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Parameters:

<SearchLimit> The value range depends on the frequency range or measurement time.
The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: left diagram border

Example: `CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:LEFT 10MHz`
Sets the left limit of the search range to 10 MHz.

Manual operation: See "Search Limits (Left / Right)" on page 95
See "Left Limit / Right Limit" on page 172

CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT <SearchLimit>

This command defines the right limit of the marker search range for *all* markers in *all* windows (<m>, <n> are irrelevant).

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Parameters:

<Limit> The value range depends on the frequency range or measurement time.
The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: right diagram border

Example: `CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Manual operation: See "Search Limits (Left / Right)" on page 95
See "Left Limit / Right Limit" on page 172

CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe] <State>

This command adjusts the marker search range to the zoom area for *all* markers in *all* windows (<m>, <n> are irrelevant).

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:X:SLIM:ZOOM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Manual operation: See "Using Zoom Limits" on page 366

CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] <State>

This command turns marker search limits on and off for *all* markers in *all* windows (<m>, <n> are irrelevant).

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:MARK:X:SLIM ON`
Switches on search limitation.

Manual operation: See "Search Limits (Left / Right)" on page 95
See "Deactivating All Search Limits" on page 95
See "Limit State" on page 171

CALCulate<n>:THReshold <Level>

This command defines a threshold level for the marker peak search (for *all* markers in *all* windows; <n> is irrelevant).

Parameters:
<Level> Numeric value. The value range and unit are variable.
*RST: -120 dBm

Example: `CALC:THR -82DBM`
Sets the threshold value to -82 dBm.

Manual operation: See "Search Threshold" on page 365

CALCulate<n>:THReshold:STATe <State>

This command turns a threshold for the marker peak search on and off (for *all* markers in *all* windows; <n> is irrelevant).

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:THR:STAT ON`
Switches on the threshold line.

Manual operation: See "Deactivating All Search Limits" on page 95

5.8.3.4 Positioning Markers

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT....634
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT....634
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt....634
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]....634
CALCulate<n>:DELTamarker<m>:MINimum:LEFT....635
CALCulate<n>:DELTamarker<m>:MINimum:NEXT....635
CALCulate<n>:DELTamarker<m>:MINimum:RIGHt....635
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]....635

CALCulate<n>:MARKer<m>:MAXimum:AUTO....636
CALCulate<n>:MARKer<m>:MAXimum:LEFT....636
CALCulate<n>:MARKer<m>:MAXimum:NEXT....636
CALCulate<n>:MARKer<m>:MAXimum:RIGHt....636
CALCulate<n>:MARKer<m>:MAXimum[:PEAK]....637
CALCulate<n>:MARKer<m>:MINimum:AUTO....637
CALCulate<n>:MARKer<m>:MINimum:LEFT....637
CALCulate<n>:MARKer<m>:MINimum:NEXT....637
CALCulate<n>:MARKer<m>:MINimum:RIGHt....638
CALCulate<n>:MARKer<m>:MINimum[:PEAK]....638

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

This command moves a delta marker to the next higher value.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Usage: Event

Manual operation: See "Search Next Peak" on page 368

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

This command moves a marker to the next higher value.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Usage: Event

Manual operation: See "Search Next Peak" on page 368

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt

This command moves a delta marker to the next higher value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Usage: Event

Manual operation: See "Search Next Peak" on page 368

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command moves a delta marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual operation: See "Peak Search" on page 368

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Usage: Event

Manual operation: See "Search Next Minimum" on page 368

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

This command moves a marker to the next higher minimum value.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Usage: Event

Manual operation: See "Search Next Minimum" on page 368

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Usage: Event

Manual operation: See "Search Next Minimum" on page 368

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

This command moves a delta marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual operation: See "Search Minimum" on page 368

CALCulate<n>:MARKer<m>:MAXimum:AUTO <State>

This command turns an automatic marker peak search for a trace maximum on and off. The R&S FSWP performs the peak search after each sweep.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:MAX:AUTO ON`
Activates the automatic peak search function for marker 1 at the end of each particular sweep.

Manual operation: See "Auto Max / Min Peak Search" on page 365

CALCulate<n>:MARKer<m>:MAXimum:LEFT

This command moves a marker to the next lower peak.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Usage: Event

Manual operation: See "Search Next Peak" on page 368

CALCulate<n>:MARKer<m>:MAXimum:NEXT

This command moves a marker to the next lower peak.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Usage: Event

Manual operation: See "Search Next Peak" on page 368

CALCulate<n>:MARKer<m>:MAXimum:RIGHt

This command moves a marker to the next lower peak.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Usage: Event

Manual operation: See "Search Next Peak" on page 368

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command moves a marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual operation: See "Peak Search" on page 368

CALCulate<n>:MARKer<m>:MINimum:AUTO <State>

This command turns an automatic marker peak search for a trace minimum on and off. The R&S FSWP performs the peak search after each sweep.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:MIN:AUTO ON`
Activates the automatic minimum value search function for marker 1 at the end of each particular sweep.

Manual operation: See "Auto Max / Min Peak Search" on page 365

CALCulate<n>:MARKer<m>:MINimum:LEFT

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Usage: Event

Manual operation: See "Search Next Minimum" on page 368

CALCulate<n>:MARKer<m>:MINimum:NEXT

This command moves a marker to the next minimum value.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Usage: Event

Manual operation: See "Search Next Minimum" on page 368

CALCulate<n>:MARKer<m>:MINimum:RIGHt

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Usage: Event

Manual operation: See "Search Next Minimum" on page 368

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command moves a marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual operation: See "Search Minimum" on page 368

5.8.3.5 Retrieving Marker Positions

Commands useful to retrieve marker positions described elsewhere:

- `CALCulate<n>:DELTamarker<m>:X` on page 625
- `CALCulate<n>:MARKer<m>:X` on page 627

CALCulate<n>:DELTamarker<m>:X:RELative?....638
CALCulate<n>:DELTamarker<m>:Y?....639
CALCulate<n>:MARKer<m>:Y?....639

CALCulate<n>:DELTamarker<m>:X:RELative?

This command queries the relative position of a delta marker on the x-axis.

If necessary, the command activates the delta marker first.

Return values:

<Position> Position of the delta marker in relation to the reference marker.

Example: `CALC:DELT3:X:REL?`
Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.

Usage: Query only

Manual operation: See "Marker 1/2/3/4" on page 186
See "Marker 1/2/3" on page 191

CALCulate<n>:DELTamarker<m>:Y?

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

The unit depends on the application of the command.

Table 5-8: Base unit

Parameter, measuring function or result display	Output unit
DBM | DBPW | DBUV | DBMV | DBUA	dB (lin/log)
WATT | VOLT | AMPere	dB (lin), % (log)
statistics function (APD or CCDF) on	dimensionless output

Return values:

<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example:

```
INIT:CONT OFF
```
Switches to single sweep mode.
```
INIT;*WAI
```
Starts a sweep and waits for its end.
```
CALC:DELT2 ON
```
Switches on delta marker 2.
```
CALC:DELT2:Y?
```
Outputs measurement value of delta marker 2.

Usage: Query only

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:

<Result> Result at the marker position.
The unit is variable and depends on the one you have currently set.

Example: `INIT:CONT OFF`
Switches to single measurement mode.
`CALC:MARK2 ON`
Switches marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Outputs the measured value of marker 2.

Usage: Query only

Manual operation: See "Marker Table" on page 302
See "Marker Peak List" on page 303

5.8.3.6 Using Markers in Spectrograms

- Using Markers....640
- Using Delta Markers....643

Using Markers

Commands useful to position markers in a spectrogram described elsewhere:

- `CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 636
- `CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 636
- `CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 637
- `CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 636
- `CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 637
- `CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 637
- `CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 638
- `CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 638

CALCulate<n>:MARKer<m>:SGRam:FRAMe....641
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe....641
CALCulate<n>:MARKer<m>:SGRam:SARea....641
CALCulate<n>:MARKer<m>:SPECtrogram:SARea....641
CALCulate<n>:MARKer<m>:SGRam:XY:MAXimum[:PEAK]....641
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MAXimum[:PEAK]....641
CALCulate<n>:MARKer<m>:SGRam:XY:MINimum[:PEAK]....642
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MINimum[:PEAK]....642
CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:ABOVe....642
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe....642
CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:BELow....642
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow....642
CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:NEXT....642
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT....642
CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum[:PEAK]....642
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum[:PEAK]....642
CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:ABOVe....643
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe....643

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:BELow....643
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow....643
CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:NEXT....643
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT....643
CALCulate<n>:MARKer<m>:SGRam:Y:MINimum[:PEAK]....643
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum[:PEAK]....643

CALCulate<n>:MARKer<m>:SGRam:FRAMe <Frame> | <Time>
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe <Frame> | <Time>

This command positions a marker on a particular frame.

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
The number is the (negative) distance to frame 0 in seconds.
The range depends on the history depth.

Example:
```
CALC:MARK:SGR:FRAM -20
```
Sets the marker on the 20th frame before the present.
```
CALC:MARK2:SGR:FRAM -2s
```
Sets second marker on the frame 2 seconds ago.

Manual operation: See "Frame (Spectrogram only)" on page 360

CALCulate<n>:MARKer<m>:SGRam:SARea <SearchArea>
CALCulate<n>:MARKer<m>:SPECtrogram:SARea <SearchArea>

This command defines the marker search area for all spectrogram markers in the measurement channel (<n>, <m> are irrelevant).

Parameters:

<SearchArea>

VISible
Performs a search within the visible frames.
Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

MEMory
Performs a search within all frames in the memory.

*RST: VISible

Manual operation: See "Marker Search Area" on page 367

CALCulate<n>:MARKer<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram.

Usage: Event

CALCulate<n>:MARKer<m>:SGRam:XY:MINimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MINimum[:PEAK]

This command moves a marker to the minimum level of the spectrogram.

Usage: Event

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:ABOVe
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Usage: Event

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:BELow
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Usage: Event

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Usage: Event

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum[:PEAK]

This command moves a marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Usage: Event

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:ABOVe
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Usage: Event

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:BELow
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Usage: Event

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:NEXT
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Usage: Event

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum[:PEAK]

This command moves a marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level for all frequencies and moves the marker vertically to the minimum level.

Usage: Event

Using Delta Markers

Commands to define the horizontal position of delta markers:

- `CALCulate<n>:DELTamarker<m>:MAXimum:LEFT` on page 634
- `CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 634
- `CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 634

- CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt on page 634
- CALCulate<n>:DELTamarker<m>:MINimum:LEFT on page 635
- CALCulate<n>:DELTamarker<m>:MINimum:NEXT on page 635
- CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 635
- CALCulate<n>:DELTamarker<m>:MINimum:RIGHt on page 635

CALCulate<n>:DELTamarker<m>:SGRam:FRAMe 644
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe 644
CALCulate<n>:DELTamarker<m>:SGRam:SARea 645
CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea 645
CALCulate<n>:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK] 645
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK] 645
CALCulate<n>:DELTamarker<m>:SGRam:XY:MINimum[:PEAK] 645
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MINimum[:PEAK] 645
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe 645
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe 645
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:BELow 646
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow 646
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:NEXT 646
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT 646
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK] 646
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum[:PEAK] 646
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:ABOVe 646
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe 646
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:BELow 646
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow 646
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:NEXT 647
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT 647
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum[:PEAK] 647
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum[:PEAK] 647

CALCulate<n>:DELTamarker<m>:SGRam:FRAMe <Frame> | <Time>
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe <Frame> | <Time>

This command positions a delta marker on a particular frame. The frame is relative to the position of marker 1.

The command is available for the spectrogram.

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example: `CALC:DELT4:SGR:FRAM -20`
Sets fourth deltamarker 20 frames below marker 1.
`CALC:DELT4:SGR:FRAM 2 s`
Sets fourth deltamarker 2 seconds above the position of marker 1.

Manual operation: See "Frame (Spectrogram only)" on page 360

CALCulate<n>:DELTamarker<m>:SGRam:SARea <SearchArea>
CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea <SearchArea>

This command defines the marker search area for *all* spectrogram markers in the measurement channel (<n> and <m> are irrelevant).

Parameters:

<SearchArea>

VISible
Performs a search within the visible frames.
Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

MEMory
Performs a search within all frames in the memory.

*RST: VISible

Manual operation: See "Marker Search Area" on page 367

CALCulate<n>:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram over all frequencies.

Usage: Event

CALCulate<n>:DELTamarker<m>:SGRam:XY:MINimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MINimum[:PEAK]

This command moves a delta marker to the minimum level of the spectrogram over all frequencies.

Usage: Event

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Usage: Event

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:BELow
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Usage: Event

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT

This command moves a delta marker vertically to the next higher level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Usage: Event

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum[:PEAK]

This command moves a delta marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Usage: Event

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:ABOVe
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Usage: Event

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:BELow
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Usage: Event

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:NEXT
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Usage: Event

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum[:PEAK]

This command moves a delta marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level in the whole spectrogram and moves the marker vertically to the minimum level.

Usage: Event

5.8.3.7 Marker Functions

- Signal Count....647
- Noise Marker....649
- Phase Noise Marker....650
- n dB Down Marker....651
- Band Power Marker....654
- Marker Peak List....657

Signal Count

CALCulate<n>:MARKer<m>:COUNt....647
CALCulate<n>:MARKer<m>:COUNt:FREQuency?....648
CALCulate<n>:MARKer<m>:COUNt:RESolution....648

CALCulate<n>:MARKer<m>:COUNt <State>

This command turns the frequency counter at the marker position on and off.

The frequency counter works for one marker only. If you perform a frequency count with another marker, the R&S FSWP deactivates the frequency count of the first marker.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Parameters:

<State> ON | OFF

*RST: OFF

Example:

```
INIT:CONT OFF
```
Switches to single sweep mode.
```
CALC:MARK ON
```
Switches on marker 1.
```
CALC:MARK:COUN ON
```
Switches on the frequency counter for marker 1.
```
INIT;*WAI
```
Starts a sweep and waits for the end.
```
CALC:MARK:COUN:FREQ?
```
Outputs the measured value.

Manual operation: See "Signal Count Marker State" on page 370

CALCulate<n>:MARKer<m>:COUNt:FREQuency?

This command queries the frequency at the marker position.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Before you can use the command, you have to turn on the frequency counter.

Return values:

<Frequency> Frequency at the marker position.

Example:

```
INIT:CONT OFF
```
Switches to single sweep mode.
```
CALC:MARK ON
```
Switches on marker 2.
```
CALC:MARK:COUN ON
```
Activates the frequency counter for marker 1.
```
INIT;*WAI
```
Starts a sweep and waits for the end.
```
CALC:MARK:COUN:FREQ?
```
Outputs the measured value of marker 1.

Usage: Query only

Manual operation: See "Signal Count Marker State" on page 370

CALCulate<n>:MARKer<m>:COUNt:RESolution <Resolution>

This command defines the resolution of the frequency counter.

Parameters:
<Resolution> 0.001 | 0.01 | 0.1 | 1 | 10 | 100 | 1000 | 10000 Hz
*RST: 0.1 Hz

Example: `CALC:MARK:COUN:RES 1kHz`
Sets the resolution of the frequency counter to 1 kHz.

Manual operation: See "Resolution" on page 370

Noise Marker

CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult?.....649
CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe].....649

CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult?

This command queries the result of the noise measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:
<NoiseLevel> Current noise level. The unit is the one currently active.

Example: `INIT:CONT OFF`
Switches to single sweep mode.
`CALC:MARK2 ON`
Switches on marker 2.
`CALC:MARK:FUNC:NOIS ON`
Switches on noise measurement.
`INIT;*WAI`
Starts a sweep and waits for the end.
`CALC:MARK2:NOIS:RES?`
Outputs the noise result of marker 2.

Usage: Query only

Manual operation: See "Noise Measurement State" on page 372

CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe] <State>

This command turns the noise measurement at the marker position on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:MARK:FUNC:NOIS ON`
Switches on the noise measurement.

Manual operation: See "Noise Measurement State" on page 372
See "Switching All Noise Measurements Off" on page 372

Phase Noise Marker

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:AUTO 650
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult? 650
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe] 650
CALCulate<n>:MARKer<m>:FUNCtion:PNOise:RESult? 651
CALCulate<n>:MARKer<m>:FUNCtion:PNOise[:STATe] 651

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:AUTO <State>

This command turns an automatic peak search for the fixed reference marker at the end of a sweep on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT:FUNC:PNO:AUTO ON`
Activates an automatic peak search for the reference marker in a phase-noise measurement.

Manual operation: See "Defining a Reference Point" on page 373

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult?

This command queries the result of a phase noise measurement.

If necessary, the command activates the measurement first.

This command is only available in the Spectrum application.

Return values:

<PhaseNoise> numeric value

The difference in level between the reference point and the noise power density at the position of the specified delta marker.

Example: `CALC:DELT2:FUNC:PNO:RES?`
Outputs the result of phase-noise measurement of the delta-marker 2.

Usage: Query only

Manual operation: See "Phase Noise Measurement State" on page 373

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe] <State>

This command turns the phase noise measurement at the delta marker position on and off.

The reference marker for phase noise measurements is either a normal marker or a fixed reference. If necessary, the command turns on the reference marker.

The correction values for the bandwidth and the log amplifier are taken into account in the measurement.

Parameters:

<State> ON | OFF

*RST: OFF

Example: CALC:DELT:FUNC:PNO ON
Switches on the phase-noise measurement with all delta markers.
CALC:DELT:FUNC:FIX:RPO:X 128 MHZ
Sets the frequency reference to 128 MHz.
CALC:DELT:FUNC:FIX:RPO:Y 30 DBM
Sets the reference level to +30 dBm

Manual operation: See "Phase Noise Measurement State" on page 373
See "Switching All Phase Noise Measurements Off" on page 373

CALCulate<n>:MARKer<m>:FUNCtion:PNOise:RESult?

This command queries the result of a phase noise measurement in the Analog Demodulation application.

If necessary, the command activates the measurement first.

Return values:

<PhaseNoise> numeric value

The difference between the measured carrier power and the noise power at the position of the specified (normal) marker.

Example: CALC:MARK2:FUNC:PNO:RES?
Outputs the result of phase-noise measurement of the marker 2.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:PNOise[:STATe] <State>

This command turns the phase noise measurement at the marker position on and off in the Analog Demodulation application.

Parameters:

<State> ON | OFF

*RST: OFF

Example: CALC:MARK2:FUNC:PNO ON
Switches on the phase-noise measurement for the marker 2.

n dB Down Marker

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown 652
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency? 652
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:QFACtor? 653

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult? 653
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:STATe 653
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:TIME? 654

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown <Distance>

This command defines the distance of the n dB down markers to the reference marker.

(<n>, <m> are irrelevant.)

Parameters:

<Distance> Distance of the temporary markers to the reference marker in dB.
For a positive offset, the markers T1 and T2 are placed *below* the active reference point.
For a negative offset (for example for notch filter measurements), the markers T1 and T2 are placed *above* the active reference point.

*RST: 6dB

Example: `CALC:MARK:FUNC:NDBD 3dB`
Sets the distance to the reference marker to 3 dB.

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency?

This command queries the position of the n dB down markers on the x-axis when measuring in the frequency domain.

(<n>, <m> are irrelevant.)

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:

<Frequency> **<frequency 1>**
absolute frequency of the n dB marker to the left of the reference marker in Hz

<frequency 2>
absolute frequency of the n dB marker to the right of the reference marker in Hz.

Example: `INIT:CONT OFF`
Switches to single sweep mode.
`CALC:MARK:FUNC:NDBD ON`
Switches on the n dB down function.
`INIT;*WAI`
Starts a sweep and waits for the end.
`CALC:MARK:FUNC:NDBD:FREQ?`
This command would return, for example, 100000000, 200000000, meaning that the first marker position is at 100 MHz, the second marker position is at 200 MHz

Usage: Query only

Manual operation: See "n dB down Delta Value" on page 374

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:QFACtor?

This command queries the Q factor of n dB down measurements.

(<n>, <m> are irrelevant.)

Return values:
<QFactor>

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult?

This command queries the distance of the n dB down markers from each other.

(<n>, <m> are irrelevant.)

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:

<Distance> The result depends on the span.
In case of frequency domain measurements, the command returns the bandwidth between the two n dB down markers in Hz.
In case of time domain measurements, the command returns the pulse width between the two n dB down markers in seconds.

Example:
```
INIT:CONT OFF
```
Switches to single sweep mode.
```
CALC:MARK:FUNC:NDBD ON
```
Switches on the n dB down function.
```
INIT;*WAI
```
Starts a sweep and waits for the end.
```
CALC:MARK:FUNC:NDBD:RES?
```
Outputs the measured value.

Usage: Query only

Manual operation: See "n dB down Marker State" on page 374

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:STATe <State>

This command turns the n dB Down marker function on and off.

(<n>, <m> are irrelevant.)

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:MARK:FUNC:NDBD:STAT ON`
Turns the n dB Down marker on.

Manual operation: See "n dB down Marker State" on page 374

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:TIME?

This command queries the position of the n dB down markers on the x-axis when measuring in the time domain.

(<n>, <m> are irrelevant.)

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:

<TimeX1> absolute position in time of the n dB marker to the left of the reference marker in seconds

<TimeX2> absolute position in time of the n dB marker to the right of the reference marker in seconds

Example: `INIT:CONT OFF`
Switches to single sweep mode
`CALC:MARK:FUNC:NDBD ON`
Switches on the n dB down function.
`INIT;*WAI`
Starts a sweep and waits for the end.
`CALC:MARK:FUNC:NDBD:TIME?`
Outputs the time values of the temporary markers.

Usage: Query only

Manual operation: See "n dB down Delta Value" on page 374

Band Power Marker

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE 655
CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:RESult? 655
CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:SPAN 655
CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe] 655
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult? 656
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN 656
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE 656
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe] 657

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE <Mode>

This command selects the way the results for a band power delta marker are displayed.

Parameters:

<Mode>

POWer
Result is displayed as an absolute power. The power unit depends on the `CALCulate<n>:UNIT:POWer` setting.

DENSity
Result is displayed as a density in dBm/Hz.

*RST: POWer

Manual operation: See "Power Mode" on page 376

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:RESult?

This command queries the results of the band power measurement.

Return values:

<Power> Signal power over the delta marker bandwidth.

Usage: Query only

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:SPAN <Span>

This command defines the bandwidth around the delta marker position.

Parameters:

<Span>

Frequency. The maximum span depends on the marker position and R&S FSWP model.

*RST: 5% of current span
Default unit: Hz

Manual operation: See "Span" on page 376

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe] <State>

This command turns delta markers for band power measurements on and off.

If neccessary, the command also turns on a reference marker.

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "Band Power Measurement State" on page 375
See "Switching All Band Power Measurements Off" on page 376

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult?

This command queries the results of the band power measurement.

Return values:

<Power> Signal power over the marker bandwidth.

Example: Activate the band power marker:
`CALC:MARK:FUNC:BPOW:STAT ON`
Select the density mode for the result:
`CALC:MARK:FUNC:BPOW:MODE DENS`
Query the result:
`CALC:MARK:FUNC:BPOW:RES?`
Response:
`20dBm/Hz`

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN <Span>

This command defines the bandwidth around the marker position.

Parameters:

<Span> Frequency. The maximum span depends on the marker position and R&S FSWP model.

*RST: 5% of current span
Default unit: Hz

Example: `CALC:MARK:FUNC:BPOW:SPAN 2MHz`
Measures the band power over 2 MHz around the marker.

Manual operation: See "Span" on page 376

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE <Mode>

This command selects the way the results for a band power marker are displayed.

Parameters:

<Mode> **POWer**
Result is displayed as an absolute power. The power unit depends on the `CALCulate<n>:UNIT:POWer` setting.
setting.

DENSity
Result is displayed as a density in dBm/Hz.

*RST: POWer

Example: `CALC:MARK4:FUNC:BPOW:MODE DENS`
Configures marker 4 to show the measurement results in dBm/Hz.

Manual operation: See "Power Mode" on page 376

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe] <State>

This command turns markers for band power measurements on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:MARK4:FUNC:BPOW:STAT ON`
Activates or turns marker 4 into a band power marker.

Manual operation: See "Band Power Measurement State" on page 375
See "Switching All Band Power Measurements Off" on page 376

Marker Peak List

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe] 657
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:COUNt? 657
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks[:IMMediate] 658
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE 658
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT 658
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe 659
CALCulate<n>:MARKer<m>:FUNCtion:FPEeaks:X? 659
CALCulate<n>:MARKer<m>:FUNCtion:FPEeaks:Y? 659
MMEMory:STORe<n>:PEAK 659

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe]
<State>

This command turns labels for peaks found during a peak search on and off.

The labels correspond to the marker number in the marker peak list.

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `CALC:MARK:FUNC:FPE:ANN:LAB:STAT OFF`
Removes the peak labels from the diagram

Manual operation: See "Displaying Marker Numbers" on page 378

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:COUNt?

This command queries the number of peaks that have been found during a peak search.

The actual number of peaks that have been found may differ from the number of peaks you have set to be found because of the peak excursion.

(<n>, <m> are irrelevant.)

Return values:
<NumberOfPeaks>

Example: `CALC:MARK:FUNC:FPE:COUN?`
Queries the number of peaks.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks[:IMMediate] <Peaks>

This command initiates a peak search.

Parameters:

<Peaks> This parameter defines the number of peaks to find during the search.
Note that the actual number of peaks found during the search also depends on the peak excursion you have set with `CALCulate<n>:MARKer<m>:PEXCursion`.

Range: 1 to 200

Example: `CALC:MARK:PEXC 5`
Defines a peak excursion of 5 dB, i.e. peaks must be at least 5 dB apart to be detected as a peak.
`CALC:MARK:FUNC:FPE 10`
Initiates a search for 10 peaks on the current trace.

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE <MaxNoPeaks>

This command defines the maximum number of peaks that the R&S FSWP looks for during a peak search.

Parameters:

<MaxNoPeaks> Maximum number of peaks to be determined.

Range: 1 to 200
*RST: 50

Example: `CALC:MARK:FUNC:FPE:LIST:SIZE 10`
The marker peak list will contain a maximum of 10 peaks.

Manual operation: See "Maximum Number of Peaks" on page 377

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT <SortMode>

This command selects the order in which the results of a peak search are returned.

Parameters:

<SortMode> **X**
Sorts the peaks according to increasing position on the x-axis.

Y
Sorts the peaks according to decreasing position on the y-axis.

*RST: X

Example: `CALC:MARK:FUNC:FPE:SORT Y`
Sets the sort mode to decreasing y values

Manual operation: See "Sort Mode" on page 377

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe <State>

This command turns a peak search on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:FUNC:FPE:STAT ON`
Activates marker peak search

Manual operation: See "Peak List State" on page 377

CALCulate<n>:MARKer<m>:FUNCtion:FPEeaks:X?

This command queries the position of the peaks on the x-axis.

The order depends on the sort order that has been set with `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT`.

(<n>, <m> are irrelevant.)

Return values:

<PeakPosition> Position of the peaks on the x-axis. The unit depends on the measurement.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:FPEeaks:Y?

This command queries the position of the peaks on the y-axis.

The order depends on the sort order that has been set with `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT`.

(<n>, <m> are irrelevant.)

Return values:

<PeakPosition> Position of the peaks on the y-axis. The unit depends on the measurement.

Usage: Query only

MMEMory:STORe<n>:PEAK <FileName>

This command exports the marker peak list to a file.

Parameters:

<FileName> String containing the path,name and extension of the target file.

Example: `MMEM:STOR:PEAK 'test.dat'`
Saves the current marker peak list in the file `test.dat`.

Usage: Event

Manual operation: See "Exporting the Peak List" on page 378

5.8.4 Lines

- Display Lines....660
- Limit Lines....662

5.8.4.1 Display Lines

CALCulate<n>:DLINe<k>....660
CALCulate<n>:DLINe<k>:STATe....660
CALCulate<n>:FLINe<k>....660
CALCulate<n>:FLINe<k>:STATe....661
CALCulate<n>:TLINe<k>....661
CALCulate<n>:TLINe<k>:STATe....661

CALCulate<n>:DLINe<k> <Position>

This command defines the (vertical) position of a display line.

Parameters:

<Position> The value range is variable.
You can use any unit you want, the R&S FSWP then converts the unit to the currently selected unit. If you omit a unit, the R&S FSWP uses the currently selected unit.

*RST: (state is OFF)

Example:
```
CALC:DLIN -20dBm
```
Positions the display line at -20 dBm.

Manual operation: See "Horizontal Line 1/2" on page 386

CALCulate<n>:DLINe<k>:STATe <State>

This command turns a display line on and off

Parameters:

<State> ON | OFF

*RST: OFF

Example:
```
CALC:DLIN2:STAT ON
```
Turns on display line 2.

CALCulate<n>:FLINe<k> <Frequency>

This command defines the position of a frequency line.

Parameters:

<Frequency> Note that you can not set a frequency line to a position that is outside the current span.

Range: 0 Hz to Fmax
*RST: (STATe to OFF)

Example: `CALC:FLIN2 120MHz`
Sets frequency line 2 to a frequency of 120 MHz.

Manual operation: See "Vertical Line 1/2" on page 386

CALCulate<n>:FLINe<k>:STATe <State>

This command turns a frequency line on and off

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:FLIN2:STAT ON`
Turns frequency line 2 on.

CALCulate<n>:TLINe<k> <Time>

This command defines the position of a time line.

Parameters:

<Time> Note that you can not set a time line to a position that is higher than the current sweep time.

Range: 0 s to 1600 s
*RST: (STATe to OFF)

Example: `CALC:TLIN 10ms`
Sets the first time line to 10 ms.

Manual operation: See "Vertical Line 1/2" on page 386

CALCulate<n>:TLINe<k>:STATe <State>

This command turns a time line on and off

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:TLIN:STAT ON`
Turns the first time line on.

5.8.4.2 Limit Lines

CALCulate<n>:LIMit<k>:ACTive? 662
CALCulate<n>:LIMit<k>:CLEar[:IMMediate] 663
CALCulate<n>:LIMit<k>:COMMent 663
CALCulate<n>:LIMit<k>:CONTrol[:DATA] 663
CALCulate<n>:LIMit<k>:CONTrol:DOMain 663
CALCulate<n>:LIMit<k>:CONTrol:MODE 664
CALCulate<n>:LIMit<k>:CONTrol:OFFSet 664
CALCulate<n>:LIMit<k>:CONTrol:SHIFt 664
CALCulate<n>:LIMit<k>:CONTrol:SPACing 664
CALCulate<n>:LIMit<k>:COPY 665
CALCulate<n>:LIMit<k>:DELete 665
CALCulate<n>:LIMit<k>:FAIL? 665
CALCulate<n>:LIMit<k>:LOWer[:DATA] 666
CALCulate<n>:LIMit<k>:LOWer:MARGin 666
CALCulate<n>:LIMit<k>:LOWer:MODE 666
CALCulate<n>:LIMit<k>:LOWer:OFFSet 667
CALCulate<n>:LIMit<k>:LOWer:SHIFt 667
CALCulate<n>:LIMit<k>:LOWer:SPACing 667
CALCulate<n>:LIMit<k>:LOWer:STATe 668
CALCulate<n>:LIMit<k>:LOWer:THReshold 668
CALCulate<n>:LIMit<k>:NAME 668
CALCulate<n>:LIMit<k>:STATe 668
CALCulate<n>:LIMit<k>:TRACe 669
CALCulate<n>:LIMit<k>:TRACe<t>:CHECk 669
CALCulate<n>:LIMit<k>:UNIT 669
CALCulate<n>:LIMit<k>:UPPer[:DATA] 670
CALCulate<n>:LIMit<k>:UPPer:MARGin 670
CALCulate<n>:LIMit<k>:UPPer:MODE 670
CALCulate<n>:LIMit<k>:UPPer:OFFSet 671
CALCulate<n>:LIMit<k>:UPPer:SHIFt 671
CALCulate<n>:LIMit<k>:UPPer:SPACing 671
CALCulate<n>:LIMit<k>:UPPer:STATe 672
CALCulate<n>:LIMit<k>:UPPer:THReshold 672

CALCulate<n>:LIMit<k>:ACTive?

This command queries the names of *all* active limit lines (<n>, <k> are irrelevant).

Return values:

<LimitLines> String containing the names of all active limit lines in alphabetical order.

Example: `CALC:LIM:ACT?`
Queries the names of all active limit lines.

Usage: Query only

Manual operation: See "Visibility" on page 388

CALCulate<n>:LIMit<k>:CLEar[:IMMediate]

This command deletes the result of the current limit check.

The command works on *all* limit lines in *all* measurement windows at the same time (<n>, <k> are irrelevant).

Example: `CALC:LIM:CLE`
Deletes the result of the limit check.

Usage: SCPI confirmed

CALCulate<n>:LIMit<k>:COMMent <Comment>

This command defines a comment for a limit line.

(<n> is irrelevant.)

Parameters:
<Comment> String containing the description of the limit line. The comment may have up to 40 characters.

Manual operation: See "Comment" on page 390

CALCulate<n>:LIMit<k>:CONTrol[:DATA] <LimitLinePoints>

This command defines the horizontal definition points of a limit line.

(<n> is irrelevant.)

Parameters:
<LimitLinePoints> Variable number of x-axis values.
Note that the number of horizontal values has to be the same as the number of vertical values set with `CALCulate<n>:LIMit<k>:LOWer[:DATA]` or `CALCulate<n>:LIMit<k>:UPPer[:DATA]`. If not, the R&S FSWP either adds missing values or ignores surplus values.
The unit is Hz or s.
*RST: -

Usage: SCPI confirmed

Manual operation: See "Data points" on page 392

CALCulate<n>:LIMit<k>:CONTrol:DOMain <SpanSetting>

This command selects the domain of the limit line.

(<n> is irrelevant.)

Parameters:
<SpanSetting> FREQuency | TIME
*RST: FREQuency

Manual operation: See "X-Axis" on page 391

CALCulate<n>:LIMit<k>:CONTrol:MODE <Mode>

This command selects the horizontal limit line scaling.

(<n> is irrelevant.)

Parameters:

<Mode>

ABSolute
Limit line is defined by absolute physical values (Hz or s).

RELative
Limit line is defined by relative values related to the center frequency (frequency domain) or the left diagram border (time domain).

*RST: ABSolute

CALCulate<n>:LIMit<k>:CONTrol:OFFSet <Offset>

This command defines an offset for a complete limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

(<n> is irrelevant.)

Parameters:

<Offset>

Numeric value.
The unit depends on the scale of the x-axis.

*RST: 0

Manual operation: See "X-Offset" on page 389

CALCulate<n>:LIMit<k>:CONTrol:SHIFt <Distance>

This command moves a complete limit line horizontally.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

(<n> is irrelevant.)

Parameters:

<Distance>

Numeric value.
The unit depends on the scale of the x-axis.

Manual operation: See "Shift x" on page 392

CALCulate<n>:LIMit<k>:CONTrol:SPACing <InterpolMode>

This command selects linear or logarithmic interpolation for the calculation of limit lines from one horizontal point to the next.

Parameters:

<InterpolMode> LINear | LOGarithmic

*RST: LIN

Example: `CALC:LIM:CONT:SPAC LIN`

CALCulate<n>:LIMit<k>:COPY <Line>

This command copies a limit line.

Parameters:

<Line> **1 to 8**
number of the new limit line

<name>
String containing the name of the limit line.

Example: `CALC:LIM1:COPY 2`
Copies limit line 1 to line 2.
`CALC:LIM1:COPY 'FM2'`
Copies limit line 1 to a new line named FM2.

Manual operation: See "Copy Line" on page 389

CALCulate<n>:LIMit<k>:DELete

This command deletes a limit line.

Usage: Event

Manual operation: See "Delete Line" on page 389

CALCulate<n>:LIMit<k>:FAIL?

This command queries the result of a limit check.

Note that for SEM measurements, the limit line suffix <k> is irrelevant, as only one specific SEM limit line is checked for the currently relevant power class.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:

<Result> **0**
PASS

1
FAIL

Example: `INIT;*WAI`
Starts a new sweep and waits for its end.
`CALC:LIM3:FAIL?`
Queries the result of the check for limit line 3.

Usage: Query only
SCPI confirmed

Manual operation: See "Spectrum Emission Mask" on page 15
See "Limit Check <n>" on page 116
See "Limit Check" on page 149

CALCulate<n>:LIMit<k>:LOWer[:DATA] <LimitLinePoints>

This command defines the vertical definition points of a lower limit line.

(<n> is irrelevant.)

Parameters:

<LimitLinePoints> Variable number of level values.
Note that the number of vertical values has to be the same as the number of horizontal values set with `CALCulate<n>:LIMit<k>:CONTrol[:DATA]`. If not, the R&S FSWP either adds missing values or ignores surplus values.
The unit depends on `CALCulate<n>:LIMit<k>:UNIT` on page 669.

*RST: Limit line state is OFF

Usage: SCPI confirmed

Manual operation: See "Data points" on page 392

CALCulate<n>:LIMit<k>:LOWer:MARGin <Margin>

This command defines an area around a lower limit line where limit check violations are still tolerated.

(<n> is irrelevant.)

Parameters:

<Margin> **numeric value**

*RST: 0
Default unit: dB

Manual operation: See "Margin" on page 391

CALCulate<n>:LIMit<k>:LOWer:MODE <Mode>

This command selects the vertical limit line scaling.

Parameters:

<Mode>

ABSolute
Limit line is defined by absolute physical values.
The unit is variable.

RELative
Limit line is defined by relative values related to the reference level (dB).

*RST: ABSolute

Manual operation: See "X-Axis" on page 391

CALCulate<n>:LIMit<k>:LOWer:OFFSet <Offset>

This command defines an offset for a complete lower limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Parameters:

<Offset>

Numeric value.

*RST: 0
Default unit: dB

Manual operation: See "Y-Offset" on page 389

CALCulate<n>:LIMit<k>:LOWer:SHIFt <Distance>

This command moves a complete lower limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Parameters:

<Distance>

Defines the distance that the limit line moves.
The unit depends on `CALCulate<n>:LIMit<k>:UNIT` on page 669.

Manual operation: See "Shift y" on page 392

CALCulate<n>:LIMit<k>:LOWer:SPACing <InterpolType>

This command selects linear or logarithmic interpolation for the calculation of a lower limit line from one horizontal point to the next.

Parameters:

<InterpolType>

LINear | LOGarithmic

*RST: LIN

Manual operation: See "X-Axis" on page 391
See "Y-Axis" on page 391

CALCulate<n>:LIMit<k>:LOWer:STATe <State>

This command turns a lower limit line on and off.

Before you can use the command, you have to select a limit line with `CALCulate<n>:LIMit<k>:NAME` on page 668.

(<n> is irrelevant.)

Parameters:

<State> ON | OFF

*RST: OFF

Usage: SCPI confirmed

Manual operation: See "Visibility" on page 388

CALCulate<n>:LIMit<k>:LOWer:THReshold <Threshold>

This command defines a threshold for relative limit lines.

The R&S FSWP uses the threshold for the limit check, if the limit line violates the threshold.

(<n> is irrelevant.)

Parameters:

<Threshold> Numeric value.
The unit depends on `CALCulate<n>:LIMit<k>:UNIT` on page 669.

*RST: -200 dBm

Manual operation: See "Threshold" on page 391

CALCulate<n>:LIMit<k>:NAME <Name>

This command selects a limit line that already exists or defines a name for a new limit line.

Parameters:

<Name> String containing the limit line name.

*RST: REM1 to REM8 for lines 1 to 8

Manual operation: See "Name" on page 390

CALCulate<n>:LIMit<k>:STATe <State>

This command turns the limit check for a specific limit line on and off.

To query the limit check result, use `CALCulate<n>:LIMit<k>:FAIL?`.

Note that a new command exists to activate the limit check and define the trace to be checked in one step (see `CALCulate<n>:LIMit<k>:TRACe<t>:CHECk` on page 669).

(<n> is irrelevant.)

Parameters:

<State> ON | OFF

*RST: OFF

Example: CALC:LIM:STAT ON
Switches on the limit check for limit line 1.

Usage: SCPI confirmed

Manual operation: See "Disable All Lines" on page 390

CALCulate<n>:LIMit<k>:TRACe <TraceNumber>

This command links a limit line to one or more traces.

Note that this command is maintained for compatibility reasons only. Limit lines no longer need to be assigned to a trace explicitely. The trace to be checked can be defined directly (as a suffix) in the new command to activate the limit check (see CALCulate<n>:LIMit<k>:TRACe<t>:CHECk on page 669).

Parameters:

<TraceNumber> 1 to 6

*RST: 1

Example: CALC:LIM2:TRAC 3
Assigns limit line 2 to trace 3.

CALCulate<n>:LIMit<k>:TRACe<t>:CHECk <State>

This command turns the limit check for a specific trace on and off.

To query the limit check result, use CALCulate<n>:LIMit<k>:FAIL?.

Note that this command replaces the two commands from previous signal and spectrum analyzers (which are still supported, however):

- CALCulate<n>:LIMit<k>:TRACe on page 669
- CALCulate<n>:LIMit<k>:STATe on page 668

Parameters:

<State> ON | OFF

*RST: OFF

Example: CALC:LIM3:TRAC2:CHEC ON
Switches on the limit check for limit line 3 on trace 2.

Manual operation: See "Traces to be Checked" on page 388

CALCulate<n>:LIMit<k>:UNIT <Unit>

This command defines the unit of a limit line.

(<n> is irrelevant.)

Parameters:

<Unit> DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere | DB | DBUV_M | DBUA_M | (unitless)

If you select dB as the limit line unit, the command automatically turns the limit line into a relative limit line.

*RST: DBM

Manual operation: See "Y-Axis" on page 391

CALCulate<n>:LIMit<k>:UPPer[:DATA] <LimitLinePoints>

This command defines the vertical definition points of an upper limit line.

(<n> is irrelevant.)

Parameters:

<LimitLinePoints> Variable number of level values.
Note that the number of vertical values has to be the same as the number of horizontal values set with `CALCulate<n>:LIMit<k>:CONTrol[:DATA]`. If not, the R&S FSWP either adds missing values or ignores surplus values.
The unit depends on `CALCulate<n>:LIMit<k>:UNIT` on page 669.

*RST: Limit line state is OFF

Usage: SCPI confirmed

Manual operation: See "Data points" on page 392

CALCulate<n>:LIMit<k>:UPPer:MARGin <Margin>

This command defines an area around an upper limit line where limit check violations are still tolerated.

(<n> is irrelevant.)

Parameters:

<Margin> **numeric value**

*RST: 0
Default unit: dB

Manual operation: See "Margin" on page 391

CALCulate<n>:LIMit<k>:UPPer:MODE <Mode>

This command selects the vertical limit line scaling.

Parameters:

<Mode>

ABSolute
Limit line is defined by absolute physical values.
The unit is variable.

RELative
Limit line is defined by relative values related to the reference level (dB).

*RST: ABSolute

Manual operation: See "X-Axis" on page 391

CALCulate<n>:LIMit<k>:UPPer:OFFSet <Offset>

This command defines an offset for a complete upper limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

(<n> is irrelevant.)

Parameters:

<Offset>

Numeric value.

*RST: 0
Default unit: dB

Manual operation: See "Y-Offset" on page 389

CALCulate<n>:LIMit<k>:UPPer:SHIFt <Distance>

This command moves a complete upper limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

(<n> is irrelevant.)

Parameters:

<Distance>

Defines the distance that the limit line moves.
The unit depends on `CALCulate<n>:LIMit<k>:UNIT` on page 669.

Usage: Event

Manual operation: See "Shift y" on page 392

CALCulate<n>:LIMit<k>:UPPer:SPACing <InterpolType>

This command selects linear or logarithmic interpolation for the calculation of an upper limit line from one horizontal point to the next.

Parameters:

<InterpolType>

LINear | LOGarithmic

*RST: LIN

Manual operation: See "X-Axis" on page 391
See "Y-Axis" on page 391

CALCulate<n>:LIMit<k>:UPPer:STATe <State>

This command turns an upper limit line on and off.

Before you can use the command, you have to select a limit line with `CALCulate<n>:LIMit<k>:NAME` on page 668.

(<n> is irrelevant.)

Parameters:
<State> ON | OFF
*RST: OFF

Usage: SCPI confirmed

Manual operation: See "Visibility" on page 388

CALCulate<n>:LIMit<k>:UPPer:THReshold <Limit>

This command defines an absolute limit for limit lines with a relative scale.

The R&S FSWP uses the threshold for the limit check, if the limit line violates the threshold.

(<n> is irrelevant.)

Parameters:
<Limit> Numeric value.
The unit depends on `CALCulate<n>:LIMit<k>:UNIT` on page 669.
*RST: -200
Default unit: dBm

Manual operation: See "Threshold" on page 391

6 Maintenance

The R&S FSWP does not require regular maintenance. Maintenance is essentially restricted to cleaning the R&S FSWP. It is however advisable to check the nominal data from time to time.

NOTICE

Instrument damage caused by cleaning agents

Cleaning agents contain substances that may damage the instrument. For example, cleaning agents that contain a solvent may damage the front panel labeling, plastic parts, or the display.

Never use cleaning agents such as solvents (thinners, acetone, etc), acids, bases, or other substances.

The outside of the instrument can be cleaned sufficiently using a soft, lint-free dust cloth.

The storage temperature range for the R&S FSWP is specified in the data sheet. The instrument must be protected against dust if it is to be stored for a long period.

When transporting or shipping the instrument, it is advisable to use the original packing material (especially the two protective covers for the front and rear panel).

7 Optimizing and Troubleshooting

If the results do not meet your expectations, the following sections may contain helpful hints and information.

- Error Information 674
- Error Messages in Remote Control Mode 675
- Troubleshooting Remote Operation 676
- Minimizing the Measurement Duration 678
- Improving Averaging Results 678
- Miscellaneous Troubleshooting Hints 678
- Obtaining Technical Support 679

7.1 Error Information

If errors or irregularities are detected, a keyword and an error message, if available, are displayed in the status bar.

Depending on the type of message, the status message is indicated in varying colors.

Table 7-1: Status bar information - color coding

Color	Type	Description
red	Error	An error occurred at the start or during a measurement, e.g. due to missing data or wrong settings, so that the measurement cannot be started or completed correctly.
orange	Warning	An irregular situation occurred during measurement, e.g. the settings no longer match the displayed results, or the connection to an external device was interrupted temporarily.
gray	Information	Information on the status of individual processing steps.
no color	No errors	No message displayed - normal operation.
green	Measurement successful	Some applications visualize that the measurement was successfull by showing a messsage.

If any error information is available for a measurement channel, an exclamation mark is displayed next to the channel name ( ). This is particularly useful when the MultiView tab is displayed, as the status bar in the MultiView tab always displays the information for the currently selected measurement only.

Furthermore, a status bit is set in the `STATus:QUEStionable:EXTended:INFO` register for the application concerned. Messages of a specific type can be queried using the `SYSTem:ERRor:EXTended?` command. For more information see the R&S FSWP User Manual.

The following keywords are used:

IF OVLD	Overload of the IF signal path in the A/D converter or in the digital IF. • Increase the reference level.
INPUT OVLD	The signal level at the RF input connector exceeds the maximum. The RF input is disconnected from the input mixer to protect the device. In order to re-enable measurement, decrease the level at the RF input connector and reconnect the RF input to the mixer input.
LOUNL	Error in the instrument's frequency processing hardware was detected.
NO REF	Instrument was set to an external reference but no signal was detected on the reference input.
RF OVLD	Overload of the input mixer or of the analog IF path. • Increase the RF attenuation (for RF input). • Reduce the input level (for digital input)
UNCAL	One of the following conditions applies: • Correction data has been switched off. • No correction values are available, for example after a firmware update. • Record the correction data by performing a self alignment
WRONG_FW	The firmware version is out-of-date and does not support the currently installed hardware. Until the firmware version is updated, this error message is displayed and self-alignment fails. (For details refer to the R&S FSWP User Manual).

7.2 Error Messages in Remote Control Mode

In remote control mode error messages are entered in the error/event queue of the status reporting system and can be queried with the command `SYSTem:ERRor?`. The answer format of R&S FSWP to the command is as follows:

```
<error code>, "<error text with queue query>; <remote control command concerned>"
```

The indication of the remote control command with prefixed semicolon is optional.

Example:

The command `TEST:COMMAND` generates the following answer to the query `SYSTem:ERRor?`

```
-113,"Undefined header;TEST:COMMAND"
```

There are two types of error messages:

- Error messages defined by SCPI are marked by negative error codes. These messages are defined and described in the SCPI standard and not listed here.
- Device-specific error messages use positive error codes. These messages are described below.

Table 7-2: Device-specific error messages

Error code	Error text in the case of queue poll Error explanation
1052	**Frontend LO is Unlocked** This message is displayed when the phase regulation of the local oscillator fails in the RF front-end.
1060	**Trigger-Block Gate Delay Error- gate length < Gate Delay** This message is displayed when the gate signal length is not sufficient for the pull-in delay with a predefined gate delay.
1064	**Tracking LO is Unlocked** This message is displayed when the phase regulation of the local oscillator fails on the external generator module.
2028	**Hardcopy not possible during measurement sequence** This message is displayed when a printout is started during scan sequences that cannot be interrupted. Such sequences are for example: • Recording the system error correction data (alignment) • Instrument self-test In such cases synchronization to the end of the scan sequence should be performed prior to starting the printout.
2033	**Printer Not Available** This message is displayed when the selected printer is not included in the list of available output devices. A possible cause is that the required printer driver is missing or incorrectly installed.
2034	**CPU Temperature is too high** This message is displayed when the temperature of the processor exceeds 70 °C.

Table 7-3: Power Sensor errors

Status bar message	Description
Zeroing could not be performed	Zeroing could not be performed because the RF power applied is too high.
Power sensor zero failed	

7.3 Troubleshooting Remote Operation

If problems arise during measurement in remote operation, try the following methods to solve them.

Uncompleted sequential commands - blocked remote channels

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel to the R&S FSWP is blocked for further commands. In this case, you must interrupt processing on the remote channel in order to abort the measurement.

To regain control over a blocked remote channel

Usually, if you wait a minute for the VISA connection to detect the lost connection and clear the control channel by itself, you can then re-establish the connection again. If this fails, try the following:

1. Press "Local" on the front panel of the R&S FSWP to return to manual operation (if not disabled). Then re-establish the connection.
2. Send a "Device Clear" command from the control instrument to the R&S FSWP to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:
   - **Visa**: `viClear()`
   - **GPIB**: `ibclr()`
   - **RSIB**: `RSDLLibclr()`

   The remote channel currently processing the uncompleted command is then ready to receive further commands again.
3. On the remote channel performing the measurement, send the SCPI command `ABORt` to abort the current measurement and reset the trigger system.
4. If the R&S FSWP still does not react to the remote commands, switch it off and back on.

Ignored commands

When a remote command attempts to define incompatible settings, the command is ignored and the instrument status remains unchanged, i.e. other settings are not automatically adapted. Therefore, control programs should always define an initial instrument status (e.g. using the *RST command) and then implement the required settings.

Detecting false commands

If a remote program does not provide the expected results and you are using a GPIB connection, you can log the commands and any errors that may occur. To activate the SCPI error log function, in the "Network + Remote" dialog box, in the "GPIB" tab, select"I/O Logging".

All remote control commands received by the R&S FSWP are recorded in the following log file:

`C:\R_S\instr\ScpiLogging\ScpiLog.txt`

Logging the commands may be extremely useful for debug purposes, e.g. in order to find misspelled keywords in control programs. However, remember to turn off the logging function after debugging to avoid unnecessary access to the hard drive and use of storage space.

7.4 Minimizing the Measurement Duration

If you want to minimize the measurement duration, try the following methods to optimize the measurement:

- Reduce the **span** of the measurement to the relevant parts of the signal only.
- Increase the **RBW** to minimize the measurement time; however, consider the requirements of the standard if you need to measure according to standard!
- Take advantage of the **speed optimization mode** in the "Sweep" settings if you do not require the larger dynamic range (see "Optimization" on page 266).
- Reduce the **sweep time** and thus the amount of data to be captured and calculated; however, consider the requirements regarding the standard deviation.
- To determine average (or peak) values, use an **RMS detector (or peak detector) with a higher sweep time** instead of trace averaging to obtain better average power results in less time. Furthermore, enforce the use of the **sweep type "FFT"** (as opposed to "Auto"; in Sweep mode, the averaging effect of the RMS detector may be less efficient).
- When performing multiple measurements, use **multiple measurement channels** to switch between measurements rather than changing the settings within one channel repeatedly.
  Take advantage of the **Sequencer** function to switch between multiple measurements automatically or continuously (see the R&S FSWP User Manual).

7.5 Improving Averaging Results

Instead of **trace averaging**, use an RMS detector with a higher sweep time to obtain better average power results in less time. Furthermore, enforce the use of the **sweep type "FFT"** (as opposed to "Auto"; in Sweep mode, the averaging effect of the RMS detector may be less efficient).

In FFT mode, FFTs are calculated per bin and combined using the RMS detector. For trace averaging, on the other hand, the local oscillator must be switched repeatedly for each trace, which takes additional time.

Generally, a higher **sweep time** leads to more data to be averaged and thus stabilizes the results. In FFT mode, a higher sweep time means more FFTs are calculated and combined per bin.

Thus, in the same capture time, the FFT mode with an RMS detector can provide better results than an averaged trace.

7.6 Miscellaneous Troubleshooting Hints

Power levels for low frequency signals not correct 679
Invalid trace display 679
Data capturing takes too long 679

Power levels for low frequency signals not correct
By default, the R&S FSWP uses AC coupling for RF input. For very low frequencies, the input signal may be distorted with this setting. In this case, use DC coupling instead. To change the setting, select INPUT/OUPUT > "Input Source Config > Radio Frequency > Input Coupling > DC".

Invalid trace display
If output to the IF 2 GHZ OUT connector is activated, the measured values are no longer sent to the display; thus, the trace data currently displayed on the R&S FSWP becomes invalid. A message in the status bar indicates this situation.

Data capturing takes too long
Particularly for FFT sweeps, the time required to process the data may be considerably longer than the time required to capture the data. Thus, if you only consider the defined sweep time, you may assume an error has occurred if the measurement takes longer than expected.

However, while the sweep time only defines the time in which data is actually captured, the total sweep *duration* includes the time required for capturing *and processing* the data. Thus, for FFT sweeps in the Spectrum application, the sweep duration is now also indicated in the channel bar, behind the sweep time. In remote operation, the estimated sweep duration can be queried for all sweep modes (also zero span and frequency sweeps).

Tip: To determine the necessary timeout for data capturing in a remote control program, double the estimated time and add 1 second.

Remote command:
`[SENSe:]SWEep:DURation?` on page 586

7.7 Obtaining Technical Support

If problems occur, the instrument generates error messages which in most cases will be sufficient for you to detect the cause of an error and find a remedy.

Error messages are described in chapter 7, "Optimizing and Troubleshooting", on page 674.

Error messages are described in the "Troubleshooting" section of the user manuals.

In addition, our customer support centers are there to assist you in solving any problems that you may encounter with your R&S FSWP. We will find solutions more quickly and efficiently if you provide us with the information listed below.

- **System Configuration:** The "System Configuration" dialog box (in the "Setup" menu) provides information on:
  - **Hardware Info:** hardware assemblies
  - **Versions and Options:** the status of all software and hardware options installed on your instrument
  - **System Messages:** messages on any errors that may have occurred

An .xml file with information on the system configuration ("device footprint") can be created automatically (using the `DIAGnostic:SERVice:SINFo` command or as described in "To collect the support information" on page 680).

- **Error Log:** The `RSError.log` file (in the `log` directory of the main installation directory) contains a chronological record of errors.
- **Support file:** a *.zip file with important support information can be created automatically (in the `user` directory of the main installation directory). The *.zip file contains the system configuration information ("device footprint"), the current eeprom data and a screenshot of the screen display.

See also the R&S FSWP User Manual, chapter "Service Functions".

To collect the support information

1. Press the SETUP key.
2. Select "Service > R&S Support" and then "Create R&S Support Information".

   The file is stored as
   `<installation_directory>\user\`
   `<inst_model>_<serial-no>_<date_and_time>.zip`
   The file is stored as `C:\R_S\instr\user\FSWP_*.zip`.

   Attach the support file to an e-mail in which you describe the problem and send it to the customer support address for your region as listed in the Internet (http://www.rohde-schwarz.com/en/service-support/customer_support_107711.html).

Packing and transporting the instrument

If the instrument needs to be transported or shipped, e.g. due to damage during delivery, observe the notes described in the R&S FSWP Getting Started.

List of Commands

[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion] 608
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO 608
[SENSe:]ADJust:ALL 597
[SENSe:]ADJust:CONFigure:DURation 597
[SENSe:]ADJust:CONFigure:DURation:MODE 597
[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer 598
[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer 598
[SENSe:]ADJust:CONFigure:TRIG 599
[SENSe:]ADJust:FREQuency 599
[SENSe:]ADJust:LEVel 599
[SENSe:]AVERage<n>:COUNt 584
[SENSe:]AVERage<n>:TYPE 584
[SENSe:]AVERage<n>[:STATe<t>] 584
[SENSe:]BANDwidth:VIDeo 582
[SENSe:]BANDwidth:VIDeo:AUTO 582
[SENSe:]BANDwidth:VIDeo:RATio 583
[SENSe:]BANDwidth:VIDeo:TYPE 583
[SENSe:]BANDwidth[:RESolution] 581
[SENSe:]BANDwidth[:RESolution]:AUTO 581
[SENSe:]BANDwidth[:RESolution]:FFT 585
[SENSe:]BANDwidth[:RESolution]:RATio 581
[SENSe:]BANDwidth[:RESolution]:TYPE 582
[SENSe:]BWIDth:VIDeo 582
[SENSe:]BWIDth:VIDeo:AUTO 582
[SENSe:]BWIDth:VIDeo:RATio 583
[SENSe:]BWIDth:VIDeo:TYPE 583
[SENSe:]BWIDth[:RESolution] 581
[SENSe:]BWIDth[:RESolution]:AUTO 581
[SENSe:]BWIDth[:RESolution]:FFT 585
[SENSe:]BWIDth[:RESolution]:RATio 581
[SENSe:]BWIDth[:RESolution]:TYPE 582
[SENSe:]CORRection:COLLect[:ACQuire] 558
[SENSe:]CORRection:METHod 559
[SENSe:]CORRection:RECall 559
[SENSe:]CORRection:TRANsducer:ADJust:RLEVel[:STATe] 600
[SENSe:]CORRection:TRANsducer:COMMent 600
[SENSe:]CORRection:TRANsducer:DATA 600
[SENSe:]CORRection:TRANsducer:DELete 601
[SENSe:]CORRection:TRANsducer:GENerator 560
[SENSe:]CORRection:TRANsducer:SCALing 601
[SENSe:]CORRection:TRANsducer:SELect 601
[SENSe:]CORRection:TRANsducer:UNIT 602
[SENSe:]CORRection:TRANsducer[:STATe] 602
[SENSe:]CORRection[:STATe] 560
[SENSe:]ESPectrum<sb>:BWID 467
[SENSe:]ESPectrum<sb>:FILTer[:RRC]:ALPHa 468
[SENSe:]ESPectrum<sb>:FILTer[:RRC][:STATe] 468

[SENSe:]ESPectrum<sb>:HighSPeed....454
[SENSe:]ESPectrum<sb>:MSR:APPLy....474
[SENSe:]ESPectrum<sb>:MSR:BAND....474
[SENSe:]ESPectrum<sb>:MSR:BCATegory....475
[SENSe:]ESPectrum<sb>:MSR:CLAS....476
[SENSe:]ESPectrum<sb>:MSR:GSM:CARR....476
[SENSe:]ESPectrum<sb>:MSR:GSM:CPResent....477
[SENSe:]ESPectrum<sb>:MSR:LTE:CPResent....478
[SENSe:]ESPectrum<sb>:MSR:MPOWer....478
[SENSe:]ESPectrum<sb>:MSR:RFBWidth....479
[SENSe:]ESPectrum<sb>:PRESet:RESTore....451
[SENSe:]ESPectrum<sb>:PRESet:STORe....451
[SENSe:]ESPectrum<sb>:PRESet[:STANdard]....450
[SENSe:]ESPectrum<sb>:RANGe<range>:BANDwidth:VIDeo....455
[SENSe:]ESPectrum<sb>:RANGe<range>:BANDwidth[:RESolution]....455
[SENSe:]ESPectrum<sb>:RANGe<range>:COUNt?....455
[SENSe:]ESPectrum<sb>:RANGe<range>:DELete....456
[SENSe:]ESPectrum<sb>:RANGe<range>:FILTer:TYPE....456
[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:ATTenuation....457
[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:ATTenuation:AUTO....458
[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:GAIN....458
[SENSe:]ESPectrum<sb>:RANGe<range>:INPut:GAIN:STATe....459
[SENSe:]ESPectrum<sb>:RANGe<range>:INSert....459
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:STARt....459
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:STOP....460
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt....461
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt:ABS....461
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt:FUNCtion....462
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP....462
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:ABSolute....463
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:FUNCtion....464
[SENSe:]ESPectrum<sb>:RANGe<range>:LIMit<PClass>:STATe....464
[SENSe:]ESPectrum<sb>:RANGe<range>:MLCalc....452
[SENSe:]ESPectrum<sb>:RANGe<range>:MLCalc....465
[SENSe:]ESPectrum<sb>:RANGe<range>:POINts:MIN[:VALue]....465
[SENSe:]ESPectrum<sb>:RANGe<range>:RLEVel....466
[SENSe:]ESPectrum<sb>:RANGe<range>:SWEep:TIME....466
[SENSe:]ESPectrum<sb>:RANGe<range>:SWEep:TIME:AUTO....466
[SENSe:]ESPectrum<sb>:RANGe<range>:TRANsducer....467
[SENSe:]ESPectrum<sb>:RANGe<range>[:FREQuency]:STARt....456
[SENSe:]ESPectrum<sb>:RANGe<range>[:FREQuency]:STOP....457
[SENSe:]ESPectrum<sb>:RRANge?....468
[SENSe:]ESPectrum<sb>:RTYPe....468
[SENSe:]ESPectrum<sb>:SBCENTER....453
[SENSe:]ESPectrum<sb>:SBCOUNT....453
[SENSe:]FREQuency:CENTer....570
[SENSe:]FREQuency:CENTer:STEP....570
[SENSe:]FREQuency:CENTer:STEP:AUTO....570
[SENSe:]FREQuency:CENTer:STEP:LINK....571
[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor....571

[SENSe:]FREQuency:OFFSet....571
[SENSe:]FREQuency:SPAN....572
[SENSe:]FREQuency:SPAN:FULL....572
[SENSe:]FREQuency:STARt....572
[SENSe:]FREQuency:STOP....573
[SENSe:]LIST:POWer:RESult?....522
[SENSe:]LIST:POWer:SET....523
[SENSe:]LIST:POWer:STATe....524
[SENSe:]LIST:POWer[:SEQuence]....522
[SENSe:]LIST:RANGe<range>:BANDwidth:VIDeo....486
[SENSe:]LIST:RANGe<range>:BANDwidth[:RESolution]....486
[SENSe:]LIST:RANGe<range>:BREak....486
[SENSe:]LIST:RANGe<range>:COUNt?....486
[SENSe:]LIST:RANGe<range>:DELete....487
[SENSe:]LIST:RANGe<range>:DETector....487
[SENSe:]LIST:RANGe<range>:FILTer:TYPE....487
[SENSe:]LIST:RANGe<range>:INPut:ATTenuation....489
[SENSe:]LIST:RANGe<range>:INPut:ATTenuation:AUTO....489
[SENSe:]LIST:RANGe<range>:INPut:GAIN:STATe....489
[SENSe:]LIST:RANGe<range>:INPut:GAIN[:VALue]....490
[SENSe:]LIST:RANGe<range>:LIMit:STARt....490
[SENSe:]LIST:RANGe<range>:LIMit:STATe....490
[SENSe:]LIST:RANGe<range>:LIMit:STOP....491
[SENSe:]LIST:RANGe<range>:POINts[:VALue]....491
[SENSe:]LIST:RANGe<range>:RLEVel....491
[SENSe:]LIST:RANGe<range>:SWEep:TIME....492
[SENSe:]LIST:RANGe<range>:SWEep:TIME:AUTO....492
[SENSe:]LIST:RANGe<range>:TRANsducer....492
[SENSe:]LIST:RANGe<range>[:FREQuency]:STARt....488
[SENSe:]LIST:RANGe<range>[:FREQuency]:STOP....488
[SENSe:]MPOWer:[:SEQuence]....528
[SENSe:]MPOWer:FTYPe....527
[SENSe:]MPOWer:RESult:MIN?....529
[SENSe:]MPOWer:RESult[:LIST]?....527
[SENSe:]PMETer<p>:DCYCle:VALue....550
[SENSe:]PMETer<p>:DCYCle[:STATe]....550
[SENSe:]PMETer<p>:FREQuency....551
[SENSe:]PMETer<p>:FREQuency:LINK....551
[SENSe:]PMETer<p>:MTIMe....552
[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt....552
[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe]....552
[SENSe:]PMETer<p>:ROFFset[:STATe]....553
[SENSe:]PMETer<p>:TRIGger:DTIMe....553
[SENSe:]PMETer<p>:TRIGger:HOLDoff....553
[SENSe:]PMETer<p>:TRIGger:HYSTeresis....554
[SENSe:]PMETer<p>:TRIGger:LEVel....554
[SENSe:]PMETer<p>:TRIGger:SLOPe....555
[SENSe:]PMETer<p>:TRIGger[:STATe]....555
[SENSe:]PMETer<p>:UPDate[:STATe]....555
[SENSe:]PMETer<p>[:STATe]....550

[SENSe:]POWer:ACHannel:ACPairs....414
[SENSe:]POWer:ACHannel:AGCHannels....432
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ACHannel....414
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ALTernate<ch>....414
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:GAP<gap>....432
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:UACHannel....432
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:UALTernate<ch>....433
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>]....415
[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel....418
[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch>....418
[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch>....419
[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>....433
[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLock<sb>:CHANnel<ch>....433
[SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel....434
[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch>....434
[SENSe:]POWer:ACHannel:FILTer:ALPHa[:ALL]....418
[SENSe:]POWer:ACHannel:FILTer:STATe:GAP<gap>....434
[SENSe:]POWer:ACHannel:FILTer:STATe:SBLock<sb>:CHANnel<ch>....435
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel....419
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALL....419
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch>....419
[SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch>....420
[SENSe:]POWer:ACHannel:FILTer[:STATe]:UACHannel....435
[SENSe:]POWer:ACHannel:FILTer[:STATe]:UALTernate<ch>....435
[SENSe:]POWer:ACHannel:GAP<gap>:MSIZe....435
[SENSe:]POWer:ACHannel:MODE....443
[SENSe:]POWer:ACHannel:NAME:ACHannel....415
[SENSe:]POWer:ACHannel:NAME:ALTernate<ch>....415
[SENSe:]POWer:ACHannel:NAME:CHANnel<ch>....416
[SENSe:]POWer:ACHannel:NAME:GAP<gap>....436
[SENSe:]POWer:ACHannel:NAME:UACHannel....436
[SENSe:]POWer:ACHannel:NAME:UALTernate<ch>....436
[SENSe:]POWer:ACHannel:PRESet....411
[SENSe:]POWer:ACHannel:PRESet:RLEVel....411
[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE....420
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO....420
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual....421
[SENSe:]POWer:ACHannel:SBCount....437
[SENSe:]POWer:ACHannel:SBLock<sb>:BANDwidth|BWIDth[:CHANnel<ch>]....437
[SENSe:]POWer:ACHannel:SBLock<sb>:CENTer[:CHANnel<ch>]....437
[SENSe:]POWer:ACHannel:SBLock<sb>:FREQuency:CENTer....438
[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>]....438
[SENSe:]POWer:ACHannel:SBLock<sb>:RFBWidth....438
[SENSe:]POWer:ACHannel:SBLock<sb>:TECHnology[:CHANnel<ch>]....439
[SENSe:]POWer:ACHannel:SBLock<sb>:TXCHannel:COUNt....439
[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch>....416
[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch>....417
[SENSe:]POWer:ACHannel:SPACing:GAP<gap>....440
[SENSe:]POWer:ACHannel:SPACing:UACHannel....440
[SENSe:]POWer:ACHannel:SPACing:UALTernate<ch>....440

[SENSe:]POWer:ACHannel:SPACing[:ACHannel]....416
[SENSe:]POWer:ACHannel:SSETup....441
[SENSe:]POWer:ACHannel:TXCHannel:COUNt....417
[SENSe:]POWer:BANDwidth|BWIDth....449
[SENSe:]POWer:HSPeed....427
[SENSe:]POWer:NCORrection....575
[SENSe:]POWer:TRACe....412
[SENSe:]SWEep:COUNt....585
[SENSe:]SWEep:COUNt:CURRent?....405
[SENSe:]SWEep:DURation?....586
[SENSe:]SWEep:EGATe....594
[SENSe:]SWEep:EGATe:HOLDoff....594
[SENSe:]SWEep:EGATe:LENGth....595
[SENSe:]SWEep:EGATe:POLarity....595
[SENSe:]SWEep:EGATe:SOURce....595
[SENSe:]SWEep:EGATe:TRACe:PERiod....499
[SENSe:]SWEep:EGATe:TRACe<k>:COMMent....499
[SENSe:]SWEep:EGATe:TRACe<k>:STARt<range>....499
[SENSe:]SWEep:EGATe:TRACe<k>:STOP<range>....500
[SENSe:]SWEep:EGATe:TRACe<k>[:STATe<range>]....500
[SENSe:]SWEep:EGATe:TYPE....596
[SENSe:]SWEep:MODE....452
[SENSe:]SWEep:OPTimize....586
[SENSe:]SWEep:POINts....587
[SENSe:]SWEep:TIME....588
[SENSe:]SWEep:TIME:AUTO....588
[SENSe:]SWEep:TYPE....588
[SENSe:]SWEep:TYPE:USED....589
ABORt....402
CALCulate<n>:DELTamarker<m>:AOFF....623
CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE....655
CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:RESult?....655
CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:SPAN....655
CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe]....655
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK]....628
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X....628
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y....628
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y:OFFSet....629
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed[:STATe]....629
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:AUTO....650
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult?....650
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe]....650
CALCulate<n>:DELTamarker<m>:LINK....623
CALCulate<n>:DELTamarker<m>:LINK:TO:MARKer<m>....623
CALCulate<n>:DELTamarker<m>:MAXimum:LEFT....634
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT....634
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt....634
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]....634
CALCulate<n>:DELTamarker<m>:MINimum:LEFT....635
CALCulate<n>:DELTamarker<m>:MINimum:NEXT....635

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt 635
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] 635
CALCulate<n>:DELTamarker<m>:MODE 623
CALCulate<n>:DELTamarker<m>:MREF 624
CALCulate<n>:DELTamarker<m>:SGRam:FRAMe 644
CALCulate<n>:DELTamarker<m>:SGRam:SARea 645
CALCulate<n>:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK] 645
CALCulate<n>:DELTamarker<m>:SGRam:XY:MINimum[:PEAK] 645
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe 645
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:BELow 646
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:NEXT 646
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK] 646
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:ABOVe 646
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:BELow 646
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:NEXT 647
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum[:PEAK] 647
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe 624
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe 644
CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea 645
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK] 645
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MINimum[:PEAK] 645
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe 645
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow 646
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT 646
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum[:PEAK] 646
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe 646
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow 646
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT 647
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum[:PEAK] 647
CALCulate<n>:DELTamarker<m>:TRACe 625
CALCulate<n>:DELTamarker<m>:X 625
CALCulate<n>:DELTamarker<m>:X:RELative? 638
CALCulate<n>:DELTamarker<m>:Y? 639
CALCulate<n>:DELTamarker<m>[:STATe] 624
CALCulate<n>:DLINe<k> 660
CALCulate<n>:DLINe<k>:STATe 660
CALCulate<n>:ESPectrum:PEAKsearch:AUTO 480
CALCulate<n>:ESPectrum:PEAKsearch:DETails 493
CALCulate<n>:ESPectrum:PEAKsearch:MARGin 480
CALCulate<n>:ESPectrum:PEAKsearch:PSHow 480
CALCulate<n>:ESPectrum:PEAKsearch[:IMMediate] 480
CALCulate<n>:ESPectrum:PSEarch:AUTO 480
CALCulate<n>:ESPectrum:PSEarch:MARGin 480
CALCulate<n>:ESPectrum:PSEarch:PSHow 480
CALCulate<n>:ESPectrum:PSEarch[:IMMediate] 480
CALCulate<n>:FLINe<k> 660
CALCulate<n>:FLINe<k>:STATe 661
CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute 422
CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute:STATe 422
CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? 423

CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative] 422
CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]:STATe 423
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute 424
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute:STATe 424
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:RESult? 426
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative] 425
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative]:STATe 425
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute 429
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute:STATe 429
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR[:RELative:]STATe 430
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR[:RELative] 429
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RESult? 431
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RESult? 442
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>[:CACLr][:RELative:]STATe 431
CALCulate<n>:LIMit<k>:ACPower:GAP<gap>[:CACLr][:RELative] 430
CALCulate<n>:LIMit<k>:ACPower[:STATe] 426
CALCulate<n>:LIMit<k>:ACTive? 662
CALCulate<n>:LIMit<k>:CLEar[:IMMediate] 663
CALCulate<n>:LIMit<k>:COMMent 663
CALCulate<n>:LIMit<k>:CONTrol:DOMain 663
CALCulate<n>:LIMit<k>:CONTrol:MODE 664
CALCulate<n>:LIMit<k>:CONTrol:OFFSet 664
CALCulate<n>:LIMit<k>:CONTrol:SHIFt 664
CALCulate<n>:LIMit<k>:CONTrol:SPACing 664
CALCulate<n>:LIMit<k>:CONTrol[:DATA] 663
CALCulate<n>:LIMit<k>:COPY 665
CALCulate<n>:LIMit<k>:DELete 665
CALCulate<n>:LIMit<k>:ESPectrum<sb>:LIMits 469
CALCulate<n>:LIMit<k>:ESPectrum<sb>:MODE 470
CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass:COUNt 471
CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:LIMit[:STATe] 471
CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:MAXimum 471
CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>:MINimum 472
CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<class>[:EXCLusive] 473
CALCulate<n>:LIMit<k>:ESPectrum<sb>:RESTore 450
CALCulate<n>:LIMit<k>:ESPectrum<sb>:VALue 473
CALCulate<n>:LIMit<k>:FAIL? 665
CALCulate<n>:LIMit<k>:LOWer:MARGin 666
CALCulate<n>:LIMit<k>:LOWer:MODE 666
CALCulate<n>:LIMit<k>:LOWer:OFFSet 667
CALCulate<n>:LIMit<k>:LOWer:SHIFt 667
CALCulate<n>:LIMit<k>:LOWer:SPACing 667
CALCulate<n>:LIMit<k>:LOWer:STATe 668
CALCulate<n>:LIMit<k>:LOWer:THReshold 668
CALCulate<n>:LIMit<k>:LOWer[:DATA] 666
CALCulate<n>:LIMit<k>:NAME 668
CALCulate<n>:LIMit<k>:STATe 668
CALCulate<n>:LIMit<k>:TRACe 669
CALCulate<n>:LIMit<k>:TRACe<t>:CHECk 669
CALCulate<n>:LIMit<k>:UNIT 669

CALCulate<n>:LIMit<k>:UPPer:MARGin 670
CALCulate<n>:LIMit<k>:UPPer:MODE 670
CALCulate<n>:LIMit<k>:UPPer:OFFSet 671
CALCulate<n>:LIMit<k>:UPPer:SHIFt 671
CALCulate<n>:LIMit<k>:UPPer:SPACing 671
CALCulate<n>:LIMit<k>:UPPer:STATe 672
CALCulate<n>:LIMit<k>:UPPer:THReshold 672
CALCulate<n>:LIMit<k>:UPPer[:DATA] 670
CALCulate<n>:MARKer<m>:AOFF 625
CALCulate<n>:MARKer<m>:COUNt 647
CALCulate<n>:MARKer<m>:COUNt:FREQuency? 648
CALCulate<n>:MARKer<m>:COUNt:RESolution 648
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE 656
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult? 656
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN 656
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe] 657
CALCulate<n>:MARKer<m>:FUNCtion:CENTer 573
CALCulate<n>:MARKer<m>:FUNCtion:CSTep 573
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe] 657
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:COUNt? 657
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE 658
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT 658
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe 659
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks[:IMMediate] 658
CALCulate<n>:MARKer<m>:FUNCtion:FPEeaks:X? 659
CALCulate<n>:MARKer<m>:FUNCtion:FPEeaks:Y? 659
CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:BANDwidth:AUTO 515
CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:DISTortion? 516
CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:LIST? 516
CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:NHARmonics 515
CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:PRESet 515
CALCulate<n>:MARKer<m>:FUNCtion:HARMonics[:STATe] 514
CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:RESult? 519
CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:SEARchsignal ONCE 519
CALCulate<n>:MARKer<m>:FUNCtion:MDEPth[:STATe] 520
CALCulate<n>:MARKer<m>:FUNCtion:MSUMmary 526
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown 652
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency? 652
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:QFACtor? 653
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult? 653
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:STATe 653
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:TIME? 654
CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult? 649
CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe] 649
CALCulate<n>:MARKer<m>:FUNCtion:PNOise:RESult? 651
CALCulate<n>:MARKer<m>:FUNCtion:PNOise[:STATe] 651
CALCulate<n>:MARKer<m>:FUNCtion:POWer:MODE 408
CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet 412
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult:PHZ 442
CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect 410

CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:CATalog? 413
CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:DELete 413
CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:SAVE 413
CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe] 410
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult? 408
CALCulate<n>:MARKer<m>:FUNCtion:REFerence 575
CALCulate<n>:MARKer<m>:FUNCtion:STRack:BANDwidth 574
CALCulate<n>:MARKer<m>:FUNCtion:STRack:THReshold 574
CALCulate<n>:MARKer<m>:FUNCtion:STRack:TRACe 574
CALCulate<n>:MARKer<m>:FUNCtion:STRack[:STATe] 573
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AOFF 506
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage 507
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:AVERage:RESult? 509
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:PHOLd:RESult? 509
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:RESult? 509
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN[:STATe] 508
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd 507
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:AVERage:RESult? 510
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:PHOLd:RESult? 510
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:RESult? 510
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak[:STATe] 508
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:AVERage:RESult? 511
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:PHOLd:RESult? 511
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:RESult? 511
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS[:STATe] 508
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:AVERage:RESult? 512
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:PHOLd:RESult? 512
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:RESult? 512
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation[:STATe] 508
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary[:STATe] 507
CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult? 517
CALCulate<n>:MARKer<m>:FUNCtion:TOI:SEARchsignal ONCE 518
CALCulate<n>:MARKer<m>:FUNCtion:TOI[:STATe] 518
CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m> 626
CALCulate<n>:MARKer<m>:LOEXclude 631
CALCulate<n>:MARKer<m>:MAXimum:AUTO 636
CALCulate<n>:MARKer<m>:MAXimum:LEFT 636
CALCulate<n>:MARKer<m>:MAXimum:NEXT 636
CALCulate<n>:MARKer<m>:MAXimum:RIGHt 636
CALCulate<n>:MARKer<m>:MAXimum[:PEAK] 637
CALCulate<n>:MARKer<m>:MINimum:AUTO 637
CALCulate<n>:MARKer<m>:MINimum:LEFT 637
CALCulate<n>:MARKer<m>:MINimum:NEXT 637
CALCulate<n>:MARKer<m>:MINimum:RIGHt 638
CALCulate<n>:MARKer<m>:MINimum[:PEAK] 638
CALCulate<n>:MARKer<m>:PEXCursion 631
CALCulate<n>:MARKer<m>:SGRam:FRAMe 641
CALCulate<n>:MARKer<m>:SGRam:SAREa 641
CALCulate<n>:MARKer<m>:SGRam:XY:MAXimum[:PEAK] 641
CALCulate<n>:MARKer<m>:SGRam:XY:MINimum[:PEAK] 642

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:ABOVe....642
CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:BELow....642
CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:NEXT....642
CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum[:PEAK]....642
CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:ABOVe....643
CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:BELow....643
CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:NEXT....643
CALCulate<n>:MARKer<m>:SGRam:Y:MINimum[:PEAK]....643
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe....626
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe....641
CALCulate<n>:MARKer<m>:SPECtrogram:SARea....641
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MAXimum[:PEAK]....641
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MINimum[:PEAK]....642
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe....642
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow....642
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT....642
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum[:PEAK]....642
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe....643
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow....643
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT....643
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum[:PEAK]....643
CALCulate<n>:MARKer<m>:TRACe....627
CALCulate<n>:MARKer<m>:X....627
CALCulate<n>:MARKer<m>:X:SLIMits:LEFT....631
CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT....632
CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe]....632
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]....632
CALCulate<n>:MARKer<m>:X:SSIZe....629
CALCulate<n>:MARKer<m>:Y:PERCent....498
CALCulate<n>:MARKer<m>:Y?....639
CALCulate<n>:MARKer<m>[:STATe]....626
CALCulate<n>:MATH:MODE....613
CALCulate<n>:MATH:POSition....613
CALCulate<n>:MATH:STATe....614
CALCulate<n>:MATH[:EXPression][:DEFine]....612
CALCulate<n>:PEAKsearch:AUTO....493
CALCulate<n>:PEAKsearch:MARGin....494
CALCulate<n>:PEAKsearch:PSHow....494
CALCulate<n>:PEAKsearch:SUBRanges....494
CALCulate<n>:PMETer<p>:RELative:STATe....548
CALCulate<n>:PMETer<p>:RELative[:MAGNitude]....549
CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE....549
CALCulate<n>:PSEarch:AUTO....493
CALCulate<n>:PSEarch:DETails....493
CALCulate<n>:PSEarch:MARGin....494
CALCulate<n>:PSEarch:PSHow....494
CALCulate<n>:PSEarch:SUBRanges....494
CALCulate<n>:SGRam:CLEar[:IMMediate]....617
CALCulate<n>:SGRam:CONT....617
CALCulate<n>:SGRam:FRAMe:COUNt....617

CALCulate<n>:SGRam:FRAMe:SELect....618
CALCulate<n>:SGRam:HDEPth....618
CALCulate<n>:SGRam:TSTamp:DATA?....619
CALCulate<n>:SGRam:TSTamp[:STATe]....619
CALCulate<n>:SGRam[:STATe]....620
CALCulate<n>:SPECtrogram:CLEar[:IMMediate]....617
CALCulate<n>:SPECtrogram:CONT....617
CALCulate<n>:SPECtrogram:FRAMe:COUNt....617
CALCulate<n>:SPECtrogram:FRAMe:SELect....618
CALCulate<n>:SPECtrogram:HDEPth....618
CALCulate<n>:SPECtrogram:TSTamp:DATA?....619
CALCulate<n>:SPECtrogram:TSTamp[:STATe]....619
CALCulate<n>:SPECtrogram[:STATe]....620
CALCulate<n>:STATistics:APD[:STATe]....497
CALCulate<n>:STATistics:CCDF:X<t>?....503
CALCulate<n>:STATistics:CCDF[:STATe]....497
CALCulate<n>:STATistics:NSAMples....498
CALCulate<n>:STATistics:PRESet....501
CALCulate<n>:STATistics:RESult<t>?....504
CALCulate<n>:STATistics:SCALe:AUTO ONCE....501
CALCulate<n>:STATistics:SCALe:X:RANGe....502
CALCulate<n>:STATistics:SCALe:X:RLEVel....502
CALCulate<n>:STATistics:SCALe:Y:LOWer....502
CALCulate<n>:STATistics:SCALe:Y:UNIT....503
CALCulate<n>:STATistics:SCALe:Y:UPPer....503
CALCulate<n>:THReshold....633
CALCulate<n>:THReshold:STATe....633
CALCulate<n>:TLINe<k>....661
CALCulate<n>:TLINe<k>:STATe....661
CALCulate<n>:UNIT:POWer....576
CALibration:PMETer<p>:ZERO:AUTO ONCE....548
DIAGnostic:SERVice:NSOurce....566
DISPlay:FORMat....536
DISPlay:MINFo[:STAT]....630
DISPlay:MTABle....630
DISPlay:WSELect?....537
DISPlay[:WINDow<n>]:SELect....536
DISPlay[:WINDow<n>]:SGRam:COLor:DEFault....620
DISPlay[:WINDow<n>]:SGRam:COLor:LOWer....620
DISPlay[:WINDow<n>]:SGRam:COLor:SHAPe....621
DISPlay[:WINDow<n>]:SGRam:COLor:UPPer....621
DISPlay[:WINDow<n>]:SGRam:COLor[:STYLe]....621
DISPlay[:WINDow<n>]:SIZE....536
DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault....620
DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer....620
DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe....621
DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer....621
DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe]....621
DISPlay[:WINDow<n>]:TRACe:X:SPACing....574
DISPlay[:WINDow<n>]:TRACe:X:SPACing....611

DISPlay[:WINDow<n>]:TRACe<t>:MODE....609
DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONtinuous....610
DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture....609
DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe]....611
DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing....580
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]....578
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE....578
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE....579
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel....576
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet....576
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition....579
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue....579
DISPlay[:WINDow<n>]:TRACe<t>[:STATe]....611
DISPlay[:WINDow<n>]:TRACe<t>[:STATe]....612
DISPlay[:WINDow<n>]:ZOOM:AREA....603
DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA....603
DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe....604
DISPlay[:WINDow<n>]:ZOOM:STATe....604
FETCh:PMETer<p>?....549
FORMat:DEXPort:DSEParator....615
FORMat:DEXPort:HEADer....615
FORMat:DEXPort:TRACes....616
FORMat[:DATA]....614
INITiate<n>:CONMeas....403
INITiate<n>:CONTinuous....404
INITiate<n>:ESPectrum....451
INITiate<n>:SEQuencer:ABORt....405
INITiate<n>:SEQuencer:IMMediate....405
INITiate<n>:SEQuencer:MODE....406
INITiate<n>:SPURious....485
INITiate<n>[:IMMediate]....403
INPut:ATTenuation....577
INPut:ATTenuation:AUTO....577
INPut:ATTenuation:PROTection:RESet....545
INPut:COUPling....545
INPut:DPATh....545
INPut:FILTer:HPASs[:STATe]....546
INPut:FILTer:YIG[:STATe]....546
INPut:GAIN:STATe....578
INPut:GAIN[:VALue]....577
INPut:IMPedance....546
INPut:SELect....544
INPut:UPORt:STATe....547
INPut:UPORt[:VALue]?....547
INSTrument:CREate:DUPLicate....533
INSTrument:CREate:REPLace....533
INSTrument:CREate[:NEW]....533
INSTrument:DELete....534
INSTrument:LIST?....534
INSTrument:REName....535

INSTrument[:SELect] 535
LAYout:ADD[:WINDow]? 537
LAYout:CATalog[:WINDow]? 538
LAYout:IDENtify[:WINDow]? 539
LAYout:REMove[:WINDow] 539
LAYout:REPLace[:WINDow] 540
LAYout:SPLitter 540
LAYout:WINDow<n>:ADD? 542
LAYout:WINDow<n>:IDENtify? 542
LAYout:WINDow<n>:REMove 542
LAYout:WINDow<n>:REPLace 543
MMEMory:SELect[:ITEM]:TRANsducer:ALL 600
MMEMory:STORe<n>:LIST 481
MMEMory:STORe<n>:PEAK 659
MMEMory:STORe<n>:SPECtrogram 622
MMEMory:STORe<n>:SPURious 495
MMEMory:STORe<n>:TRACe 605
OUTPut:IF:IFFRequency 566
OUTPut:IF[:SOURce] 566
OUTPut:TRIGger<port>:DIRection 567
OUTPut:TRIGger<port>:LEVel 567
OUTPut:TRIGger<port>:OTYPe 567
OUTPut:TRIGger<port>:PULSe:IMMediate 568
OUTPut:TRIGger<port>:PULSe:LENGth 568
OUTPut:UPORt:STATe 569
OUTPut:UPORt[:VALue] 568
READ:PMETer<p>? 550
SOURce:EXTernal:FREQuency 560
SOURce:EXTernal:FREQuency:COUPling[:STATe] 561
SOURce:EXTernal:FREQuency:OFFSet 562
SOURce:EXTernal:FREQuency:SWEep[:STATe] 562
SOURce:EXTernal:FREQuency[:FACTor]:DENominator 561
SOURce:EXTernal:FREQuency[:FACTor]:NUMerator 562
SOURce:EXTernal:POWer[:LEVel] 563
SOURce:EXTernal:ROSCillator[:SOURce] 563
SOURce:EXTernal[:STATe] 563
SOURce:POWer[:LEVel][:IMMediate]:OFFSet 563
SYSTem:COMMunicate:GPIB:RDEVice:GENerator:ADDRess 564
SYSTem:COMMunicate:RDEVice:GENerator:INTerface 564
SYSTem:COMMunicate:RDEVice:GENerator:LINK 564
SYSTem:COMMunicate:RDEVice:GENerator:TYPE 565
SYSTem:COMMunicate:RDEVice:PMETer:COUNt? 556
SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe] 556
SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine 556
SYSTem:COMMunicate:TCPip:RDEVice:GENerator:ADDRess 565
SYSTem:PRESet 543
SYSTem:PRESet:CHANnel[:EXECute] 543
SYSTem:SEQuencer 407
TRACe<n>:COPY 612
TRACe<n>[:DATA] 606

TRACe<n>[:DATA]:MEMory? 607
TRACe<n>[:DATA]:X? 608
TRIGger[:SEQuence]:DTIMe 589
TRIGger[:SEQuence]:HOLDoff[:TIME] 590
TRIGger[:SEQuence]:IFPower:HOLDoff 590
TRIGger[:SEQuence]:IFPower:HYSTeresis 590
TRIGger[:SEQuence]:LEVel:IFPower 591
TRIGger[:SEQuence]:LEVel:IQPower 591
TRIGger[:SEQuence]:LEVel:RFPower 592
TRIGger[:SEQuence]:LEVel:VIDeo 592
TRIGger[:SEQuence]:LEVel[:EXTernal<port>] 591
TRIGger[:SEQuence]:SLOPe 592
TRIGger[:SEQuence]:SOURce 592
TRIGger[:SEQuence]:TIME:RINTerval 593
UNIT<n>:PMETer<p>:POWer 557
UNIT<n>:PMETer<p>:POWer:RATio 557

Index

Symbols

# of Samples
Softkey (APD, CCDF) ... 161
% Power Bandwidth
Softkey ... 94

A

Aborting
Sweep ... 267, 268, 335
AC/DC coupling ... 197
ACLR
MSR signals ... 47
Programming example ... 443
Results (remote) ... 408
see CP/ACLR ... 14, 37
ACLR Mode
Softkey ... 56, 66
ACP
see CP/ACLR ... 14
Active
Transducer lines ... 294
Adjacent channels
MSR ... 72
MSR ACLR ... 71
MSR, bandwidth ... 73
MSR, configuring ... 72
MSR, spacing ... 72
MSR, weighting filters ... 73
Adjust settings
Softkey (APD) ... 161, 165
Softkey (C/N) ... 90
Softkey (CP/ACLR) ... 57, 67
Softkey (OBW) ... 95
Adjust X-Axis
Softkey ... 149
All Functions Off ... 378
Alpha
RRC filter (SEM) ... 121
AM modulation
Measurement example ... 28, 29
AM modulation depth ... 189
About ... 189
Configuring ... 190
Determining ... 192
Markers ... 191
Programming example ... 520
Results ... 189
Search signals ... 191
AM Modulation Depth ... 16
Amplitude
Configuration ... 249
Distribution, white noise ... 167
Optimizing display ... 254
Probability, white noise ... 167
Scaling ... 254
Settings ... 249
Analysis bandwidth ... 160
Statistics ... 160, 169
Analysis BW
Softkey (APD, CCDF) ... 160
APD ... 154
About ... 154
Application ... 155
Configuring ... 159
Gate ranges ... 161
Gated trigger ... 158, 161
Measurement ... 15
Measurement example ... 167
Performing ... 159, 165
Results ... 155
see also Statistics ... 154
Using gate ranges ... 165
APX
External generator ... 214, 219
Arranging
Windows ... 307
ASCII trace export ... 343
Attenuation ... 251
Auto ... 251
Impact ... 248
Manual ... 251
Protective ... 195
Protective (remote) ... 545
Audio signals
Output (remote) ... 235, 566
Auto adjustment
Triggered measurement ... 599
Auto all ... 289
Auto frequency ... 289
Auto level
Hysteresis ... 290
Reference level ... 251, 290
Softkey ... 251, 290
Auto Peak detector ... 313
Auto scaling ... 253
Auto settings
Meastime Auto ... 290
Meastime Manual ... 290
Automatic coupling
Frequencies, external generator ... 217, 223
AUX control
TTL synchronization, external generator ... 208
Average count ... 260, 265, 329
Power sensor ... 204
Average detector ... 313
Average mode
Traces ... 329
Averaging
Continuous measurement ... 317
Single measurement ... 317
Sweep count ... 317
Traces ... 318
Traces (algorithm) ... 317
Traces (remote control) ... 584

B

Band power
Marker ... 357
Band power measurement
Activating/Deactivating ... 375
Deactivating ... 376

Power mode ... 376
Span ... 376
Bandwidth
Configuration (Softkey) ... 261
Coupling ... 257
CP/ACLR ... 59
Default settings ... 255
MSR sub blocks ... 69
MSR, adjacent channels ... 73
MSR, gap channels ... 76
MSR, Tx channel ... 70
Resolution ... 256, 263
Video ... 256, 263
Burst signals
Measurement example ... 31

C

C/N, C/N0
see Carrier-to-Noise ... 87
Calibration
External generator ... 213
How to, external generator ... 227
Normalization, external generator ... 225
Performing with external generator ... 227
Reference trace, external generator ... 214
Reflection open measurement, external generator ... 225
Reflection short measurement, external generator ... 225
Removing component effects, external generator ... 228
Restoring settings, external generator ... 215, 225
Storing results, external generator ... 214
Transmission measurement, external generator ... 224
Capture time
see also Measurement time ... 586, 588
Carrier Noise Config
Softkey ... 89
Carrier-to-Noise ... 87
Activating ... 89
Channel bandwidth ... 90
Configuring ... 89
Determining ... 90
Measurement ... 14, 87
Measurement process ... 87
Results ... 88
Span ... 88
CCDF ... 154
About ... 154
Application ... 155
Configuring ... 159
Crest factor ... 157
Gate ranges ... 161
Gated trigger ... 158, 161
Measurement ... 16
Measurement example ... 167
Percent marker ... 157, 160
Performing ... 159, 165
Results ... 156
see also Statistics ... 154
Using gate ranges ... 165
Center = Mkr Freq ... 369
Center frequency ... 242
Automatic configuration ... 289
MSR sub blocks ... 69
MSR Tx channel ... 70
Setting to marker ... 369
Softkey ... 242
Step size ... 238, 243, 246
Sub blocks (Multi-SEM) ... 119
Ch Power ACLR
see CP/ACLR ... 14
Channel bandwidth
C/N ... 90
CP/ACLR ... 59
MSR Tx channel ... 70
MSR, adjacent channels ... 73
MSR, gap channels ... 76
OBW ... 95
Softkey ... 95
Channel bar
Information, external generator ... 219
Channel power
Comparing (CP/ACLR) ... 81
Density (CP/ACLR) ... 56, 67
see CP/ACLR ... 14
SEM results ... 98
Settings (SEM) ... 120
Channels
CP/ACLR ... 58, 68, 78
CP/ACLR measurements ... 55
Names (CP/ACLR) ... 61
Spacings (CP/ACLR) ... 59
Spacings, configuring ... 79
Weighting filters ... 61
Closing
Channels (remote) ... 534
Windows ... 307
Windows (remote) ... 539, 542
CMT
Display ... 176
Color curve
Shape ... 324, 337
Spectrograms ... 324, 342
Color mapping
Color curve ... 337
Color range ... 337
Color scheme ... 337
Softkey ... 335
Spectrograms ... 323, 335, 336, 341
Step by step ... 341
Value range ... 324
Color scheme
Spectrogram ... 323, 337
Comment
Gate ranges (statistics) ... 162
Limit lines ... 390
Transducer lines ... 296
Compatibility
Limit lines ... 382, 388
Transducer lines ... 294
Compensation
After calibration, external generator ... 229
Connectors
AUX control, external generator ... 208
External generator control ... 208
GPIB ... 208
IF/VIDEO/DEMOD ... 236
Continue single sweep
Softkey ... 17, 268
Continuous sweep
Softkey ... 17, 267, 335
Conventions
SCPI commands ... 397

Copying
Measurement channel (remote) 533
Traces 337
Coupling
Automatic, external generator 217, 223
Frequencies, external generator 216
Input (remote) 545
Manual, external generator 223
Span/RBW 257
VBW/RBW 257
Coupling ratio
Span/RBW (remote) 581
Coupling ratios
Default 265
RBW/VBW 264
Span/RBW 264
CP/ACLR 37
About 38
Absolute/relative values 56, 66
Adjust Settings 57, 67
Channel bandwidths 59
Channel names 61
Channel power density 56, 67
Channel setup 58, 68
Channel spacing 79
Channel spacings 59
Clear/Write 57, 67
Comparing channel powers 81
Configuring 51
Configuring MSR signals 62
Detector 46
Fast ACLR 41, 56
Fixed reference for CP 57
Frequency span 44
General Settings 52
General Settings for MSR 62
IBW method 41
Limit check 60
Max Hold 57, 67
Measurement 14
Measurement examples 82
Measurement methods 40
Mode 56, 66
Multicarrier 40
Noise cancellation 56, 66, 252
Number of channels 55
Optimizing 85
Performing 51
Performing measurement 78, 79
Power mode 57, 67
Power Unit 56, 67
Predefined Settings 53, 63
Predefined standards 86
RBW 45
Reference channel 55, 65
Reference level 47
Repeatability 42
Results 38
Setting up channels 78
Standards 53, 63
Standards (Softkey) 53, 63
Sweep time 44
Sweep Time 58
Trace averaging 47
Trace Selection 56, 66
Troubelshooting 85
User-defined standards 53, 64, 80
VBW 46
Weighting filters 61
Crest factor
APD 156
CCDF 157
Cumulated Measurement Time (CMT)
Harmonics 176

D

Data format
ASCII 347
Binary 347
Remote 614, 615, 616
Debugging
Remote control programs 677
Decimal separator
Trace export 331
Default coupling 265
Deleting
Limit line values 392
Settings files 127
Standards 127
Transducer factors 297
Delta markers 360
Defining 360, 371
Fixed reference marker 379
Denominator
Frequencies, external generator 217, 223
Detectors
CP/ACLR 46
Overview 313
Remote control 608
Spurious Emissions range 147
Trace 328
Diagrams
Evaluation method 302
Direct path
Remote 545
Display
Config (Softkey) 301
Evaluation bar 306
Evaluation methods 301
SmartGrid 304
Display lines 382
Defining 392
Settings 386
Drop-out time
Trigger 273, 282
Trigger (Power sensor) 205
Duplicating
Measurement channel (remote) 533
Duty cycle
Power sensor 204
Dynamic range
Intermodulation-free 183
Measuring 174

E

Edge gate
Slope 283
Electronic input attenuation 251
Error log 679
Error messages
see User Manual 674
Status bar 674

Errors
External generator ... 219
IF OVLD ... 250, 675
INPUT OVLD ... 675
LOUNL ... 675
Messages, device-specific ... 676
NO REF ... 675
RF OVLD ... 675
UNCAL ... 675
WRONG_FW ... 675
Evaluation
Lists (SEM) ... 127
Lists (Spurious) ... 149
Modes ... 301
Modes, adding ... 306
Evaluation bar
Using ... 306
Evaluation list
Details (Spurious Emissions) ... 150
Peaks (Spurious Emissions) ... 151
Spurious Emissions ... 142
Evaluation methods
Remote ... 537
Example
Calibration with an external generator ... 229
Remote control of an external generator ... 569
Exclude LO ... 364
Remote ... 631
Export format
SEM results ... 140
Spurious Emissions results ... 152
Traces ... 343
Exporting
Measurement settings ... 331
Peak list ... 378
SEM result files ... 132
Spurious Emissions result files ... 152
Trace data ... 338
Traces ... 330, 331
EXREF (status display) ... 675
External generator ... 207
Activating/Deactivating ... 222
Basics ... 208
Calibration functions ... 224
Calibration measurement settings ... 222
Channel bar information ... 219
Connections ... 208
Coupling frequencies ... 216
Errors ... 219
Generators, supported ... 211
Interface ... 221
Interface settings ... 220
Normalizing ... 225
Overloading ... 220
Recalling calibration settings ... 225
Reference level ... 215
Reference line ... 215
Reference line position ... 226
Reference line value ... 226
Reference position ... 226
Reference trace ... 215
Reference value ... 226
Reflection measurement ... 210
Reflection open measurement ... 225
Reflection short measurement ... 225
Settings ... 220
Transducer factor ... 215, 226
Transmission measurement ... 210, 224
TTL synchronization ... 208
External reference
External generator ... 211
External generator control ... 221
External trigger ... 280
Configuring power sensor ... 207
Level (power sensor) ... 204
Level (remote) ... 591
Power sensor ... 204

F

Falling
Slope (Power sensor) ... 205
Fast ACLR
Activating/Deactivating ... 56
Measurement method ... 41
Fast SEM ... 106
Consequences ... 107
Example ... 107
Multi-SEM ... 107, 109
Prerequisites ... 106
SEM ... 114
FFT filters
Mode ... 266
FFT sweep ... 258, 266
File format
Export Files ... 343
SEM export files ... 140
SEM settings files ... 134
Spurious Emissions export files ... 152
Trace export ... 343
File name
Settings ... 126
Filter types ... 259, 264
SEM range ... 114
Spurious Emissions range ... 146
Filters
5-pole ... 259
Channel ... 259
Configuration ... 261
FFT ... 266
Gaussian (3dB) ... 259
High-pass (remote) ... 546
High-pass (RF input) ... 198
Overview ... 269
RBW ... 256
RRC ... 259
VBW ... 256
Weighting (remote) ... 418
YIG (remote) ... 546
Fixed reference
Configuring ... 379
Defining ... 362, 374
Delta markers ... 379
Marker ... 353
Format
Data ... 347
Data (remote) ... 614, 615, 616
see also File format ... 343
Frame count
Softkey ... 269
Spectrograms ... 322
Frames
Spectrogram marker ... 360

Free Run
Trigger ... 280
Frequencies
Multi-SEM ... 109
Frequency
Configuration (Softkey) ... 240
Coupling (power sensor) ... 203
External generator ... 223
IF Out ... 236
Offset ... 244
Power sensor ... 202
Range ... 238
Range, defining ... 245
Span ... 242
Start ... 242
Step size ... 238
Stop ... 242
Sweep ... 266
Frequency axis
Scaling ... 239, 242
Frequency counter
see also Signal count ... 353
Frequency coupling
Automatic, external generator ... 217
External generator ... 216, 223
Reverse sweep, external generator ... 218
TTL synchronization, external generator ... 217
Frequency denominator
External generator ... 223
Frequency numerator
External generator ... 223
Frequency offset
External generator ... 217, 223
Frequency range
Calibration sweep, external generator ... 217, 224
Frequency span
CP/ACLR ... 44
Frequency sweep
Measurement ... 13
Programming example ... 530
Frequency-converting measurements
External generator ... 217
FRQ
External generator ... 219
Full span
Softkey ... 243

G

Gap
MSR, spacing ... 75
Gap channels
MSR ACLR ... 74
MSR, bandwidth ... 76
MSR, configuring ... 75
MSR, weighting filters ... 76
Gate
Delay ... 285
Length ... 285
Measurements ... 275
Mode ... 285
Ranges (statistics) ... 158
Settings ... 284
Gate ranges
Activating (statistics) ... 162
Comment (statistics) ... 162
Period (statistics) ... 162
Start/Stop (statistics) ... 162
Statistics ... 161
Gated trigger
Activating ... 284
Configuring (statistics) ... 161, 165
Delay ... 285
Example ... 166
Length ... 285
Mode ... 285
Softkey ... 161
Statistics ... 158, 161, 169
Gating
Source ... 279
Generator
Frequencies, external generator ... 217, 223
Frequency coupling, external generator ... 223
Frequency offset, external generator ... 223
Output power, external generator ... 223
Generator type
External generator ... 221
Generators
Frequency range, external generator ... 222
Power range, external generator ... 222
Setup files, external generator ... 213, 221, 222
Supported, external generator ... 211
GPIB
Address, External generator ... 221
External generator ... 221
TTL synchronization, External generator ... 221
Group delay
Smoothing ... 328

H

Harmonic Distortion ... 173
About ... 174
Basics ... 174
Configuring ... 177
Measurement ... 16
Measuring ... 179
RBW ... 178
Results ... 177
Sweep time ... 178
Harmonics
Basics ... 174
High-sensitivity ... 176
Measurement example ... 380
Measurement rules ... 176
Measurement time ... 176
Number ... 178
Origin ... 176
Power ... 177
Second harmonic intercept ... 174
High-pass filter
Remote ... 546
RF input ... 198
History
Spectrograms ... 334
History Depth
Softkey ... 334
Hold
Trace setting ... 328
Horizontal Line 1/2
Softkeys ... 386
Hysteresis
Lower (Auto level) ... 290
Trigger ... 283

Trigger (Power sensor) 205
Upper (Auto level) 290

I

I/Q Power
Trigger level (remote) 591
IBW method
CP/ACLR measurements 41
IF frequency
Output 196, 235
Output (remote) 566
IF Out Frequency 236
IF output 235
Remote 566
IF OVLD
Error 675
External generator 214, 219
IF OVLD (status display) 675
IF Power
Trigger 280
Trigger level (remote) 591
IF/VIDEO/DEMOD
Connector 196
Output 236
Impedance
Remote 546
Setting 197
Inherent noise
Cancellation 56, 66, 252
Input
Coupling 197
Coupling (remote) 545
Overload 195
Overload (remote) 545
RF 197
Settings 197
Signal, parameters 195
Source Configuration (softkey) 197
Source, Radio frequency (RF) 197
INPUT OVLD
Error 675
INPUT OVLD (status display) 675
Inserting
Limit line values 392
Transducer factors 297
Intermodulation products 180

K

Keys
MKR 358
MKR -> 363
MKR → 367
MKR FUNCT 369
Peak Search 368
RUN CONT 17, 267, 335
RUN SINGLE 17, 267, 268, 335

L

Last span
Softkey 243
Limit check
Activating/Deactivating 393
CP/ACLR 60
MSR channels 73, 76
MSR, activating 68
Results 384
SEM range 116
Spurious Emissions 145
Spurious Emissions range 149
Limit lines 382, 387
Activating/Deactivating 388
Band power marker 357
Calculation (Multi-SEM) 109, 117
Comment 390
Compatibility 382, 388
Compatible 393
Copying 389, 394
Creating 389, 394
Data points 392
Deactivating 390
Defining 393
Deleting 389, 394
Deleting values 392
Details 390
Editing 389, 394
Inserting values 392
Managing 387
Margin 391
Margins 383
Name 390
OBW 95, 365
Offsets 384
Peak search 95, 365
Saving 392
Selecting 389
SEM 104, 393
Shifting 384, 392, 395
Spurious 393
Spurious Emissions 144
Storing 386
Threshold 384, 391
Time Domain Power measurement 170
Traces 388
View filter 388
Violation 384
Visibility 388
X-axis 391
X-Offset 389
Y-axis 391
Y-Offset 389
Limits
Absolute (SEM range) 116
Absolute (Spurious Emissions range) 149
Relative (SEM range) 116
Linear scaling
X-axis 239, 242
Lines
Configuration 387
Configuration (Softkey) 386
Display 382, 386, 392
Horizontal 386
Limit, see Limit lines 387
Vertical 386
Linking
Markers 360
List evaluation 521
Evaluations 127, 149
Saving (SEM) 128
Saving (Spurious Emissions) 151
SEM 127
Softkey 127

Spurious Emissions 149
State (SEM) 128
State (Spurious Emissions) 150
Loading
Settings files 126
Logarithmic scaling
Sweep points 239
X-axis 239, 242
LOUNL
Error 675
LOUNL (status display) 675
Lower Level Hysteresis 290
LVL
External generator 219

M

Maintenance 673
Margins
Limit lines 383, 391
Peaks (SEM) 128
Peaks (Spurious Emissions) 150
Violation 384
Marker
Search area (softkey) 367
Search type (softkey) 367
Marker functions
Deactivating 378
Measurement example 380
Marker peak list
see Peak list 377
Marker table
Evaluation method 302
Marker to Trace 361
Markers 349
AM Modulation Depth measurement 191
Analyzing in detail 378
Assigned trace 361
Band power 357
Basic settings 359
Configuration 359, 361
Deactivating 361
Delta markers 360, 371
Fixed reference 353
Function configuration 369
Linking 360
Minimum 368
n dB down 356, 374
Next minimum 368
Next peak 368
Noise 354, 355
Noise measurement 371
Peak 368
Phase noise measurement 372
Position 359
Positioning 367
Querying position (remote) 639
Setting center frequency 369
Setting reference level 369
Signal count 353, 370
Softkeys (AM Modulation Depth) 191
Softkeys (TOI) 186
Spectrograms 325, 340
State 359, 371
Step size 362
Table 362
Table (evaluation method) 302
Tips 348
TOI measurement 186
Type 360, 371
X-value 359
Mask monitoring
SEM 98
Maximizing
Windows (remote) 536
Measurement
Points 313
Measurement accuracy
External generator 214
Measurement channel
Creating (remote) 533, 535
Deleting (remote) 534
Duplicating (remote) 533
Querying (remote) 534
Renaming (remote) 535
Replacing (remote) 533
Selecting (remote) 535
Measurement examples
AF of AM-modulated signal 29
AM modulation 28
CP/ACLR 82
Harmonics 380
Intermodulation 187
Level and frequency 19
Marker functions 380
OBW 96
Power of burst signals 31
Separating signals 24
Signal frequency using signal counter 20
Signal-to-noise ratio 35
Statistics 167
Time Domain Power 172
TOI 187
Measurement results
SEM 127
Spurious Emissions 149
Measurement time
Auto settings 290
Power sensor 203
Remote 586, 588
Measurements
All Functions off 17
APD 15, 154
Carrier-to-Noise 14, 87
CCDF 16, 154
CP/ACLR 14, 37
Evaluation methods 301
Frequency sweep 13
Harmonic Distortion 16, 173
OBW 14, 91
Selecting 12
SEM 15, 97
Spurious Emissions 15, 141
Statistics 154
Time Domain Power 16, 169
TOI 16, 179
Zero span 13
Measurementsition time
Statistics 161
Minimum 368
Marker positioning 368
Next 368
MKR
Key 358

MKR ->
Key ... 363
MKR →
Key ... 367
MKR FUNCT
Key ... 369
Modulation
Depth ... 16
MSR ACLR
Adjacent channel bandwidths ... 73
Adjacent channel definition ... 72
Adjacent channel setup ... 71
Adjacent channel spacing ... 72
Adjacent channel weighting filters ... 73
Adjacent channels ... 50
CACLR ... 49
Channel definition ... 48
Channel display ... 50
Configuration ... 62
Gap channel bandwidths ... 76
Gap channel definition ... 75
Gap channel setup ... 74
Gap channel spacing ... 75
Gap channel weighting filters ... 76
Gap channels ... 49
Limit check ... 73, 76
Limit checks, activating ... 68
Measurement ... 47
Number of adj. channels ... 72
Programming example ... 445
Results ... 50
Results (remote) ... 408
Signal structure ... 47
Sub block definition ... 48
Tx channel bandwidth ... 70
Weighting filters ... 71
MSR SEM
Basics ... 108
Configuration ... 122
Configuration (softkey) ... 122
Settings (Multi-SEM) ... 119
Multi-SEM
Basics ... 108
Center frequencies ... 119
Fast SEM ... 107, 109
Frequency definition ... 109
Limit line calculation ... 109, 117
MSR settings ... 119
Number of sub blocks ... 119
Results ... 100
Settings ... 118
Standard files ... 125
Standard settings files ... 119
Multi-standard radio
see MSR ... 108
Multicarrier ACLR measurement ... 40
Multiple signals
Measurement example ... 24
Multiple zoom ... 308, 310
MultiView
Tab ... 11

N

n dB down
Delta value ... 374
Marker ... 356, 374
Name
CP/ACLR channels ... 61
Limit lines ... 390
Transducer lines ... 296
Negative Peak detector ... 313
Next Minimum ... 368
Marker positioning ... 368
Next Mode X
Softkey ... 366
Next Mode Y
Softkey ... 367
Next Peak ... 368
Marker positioning ... 368
NO REF
Error ... 675
Noise
Cancellation (CP/ACLR) ... 56, 66, 252
Cancellation (remote control) ... 575
Cancellation (softkey) ... 56, 66, 252
Correction, see Cancellation ... 56, 66, 252
Density ... 354, 355
Floor (RF attenuation) ... 248
Marker ... 354, 355
Source ... 195, 236
Noise measurement
Activating/Deactivating ... 372
Deactivating ... 372
Marker ... 371
NOR
External generator ... 214, 219
Normalization
Approximate, external generator ... 214
External generator ... 214, 225
Number of Readings
Power sensor ... 204
Numerator
Frequencies, external generator ... 217, 223

O

OBW ... 91
% Power ... 94
Adjust Settings ... 95
Channel bandwidth ... 95
Configuring ... 94
Deactivating limits ... 95, 366
Determining ... 94, 96
Limits ... 95, 365
Measurement ... 14, 91
Measurement example ... 96
Multicarrier signal ... 92, 94, 96
Prerequisities ... 92
Results ... 93
Search limits ... 92, 94, 96
Occupied Bandwidth
see OBW ... 91
Offset
Frequency ... 244
Limit lines ... 384
Reference level ... 250
X-axis (statistics) ... 164
Open-circuit reflection measurement
Calibration, external generator ... 225
Options
External generator control (B10) ... 207
High-pass filter ... 198, 546
Preamplifier ... 252

Output
Audio ... 566
Configuration ... 234
IF frequencies ... 196
IF frequency (remote) ... 566
IF Out Frequency ... 236
IF source (remote) ... 566
Noise source ... 195, 236
Parameters ... 195
Settings ... 234
Trigger ... 236, 283
Video ... 235, 566
Video signal ... 196
Overload
External generator ... 214
RF input ... 195
RF input (remote) ... 545
Overloading
External generator ... 220
Overview (configuration) ... 193
OVLD
External generator ... 214

P

Parameters
Input signal ... 195
Output ... 195
partial spans ... 258, 259
Peak excursion ... 351, 365, 377
Peak list ... 352
Configuring ... 376
Displaying ... 376
Evaluation method ... 303
Exporting ... 378
Marker numbers ... 378
Maximum number of peaks ... 377
Peak excursion ... 365, 377
Sort mode ... 377
State ... 377
Peak search ... 351
Area (spectrograms) ... 367
Automatic ... 352, 365
Deactivating limits ... 95, 366
Excursion ... 351
Key ... 368
Limits ... 95, 351, 365
List ... 352
Mode ... 364, 366
Mode (spectrograms) ... 366, 367
Reference marker ... 362
Threshold ... 365
Type (spectrograms) ... 367
Zoom limits ... 366
Peaks
Displaying (SEM) ... 128
Displaying (Spurious Emissions) ... 150
Margin (SEM) ... 128
Margin (Spurious Emissions) ... 150
Marker positioning ... 368
Next ... 368
per range (Spurious Emissions) ... 151
SEM results ... 100
Softkey ... 368
Spurious Emissions ... 142
Percent marker
CCDF ... 157
Softkey (CCDF) ... 160
Period
Gate ranges (statistics) ... 162
Persistence spectrum
Spectrogram ... 324
Phase noise measurement
Activating/Deactivating ... 373
Deactivating ... 373
Marker ... 372
Reference point ... 373
Ports
User ... 568
Position
Limit line values ... 392
Transducer factors ... 297
Positive Peak detector ... 313
Power
Channel, see Channel Power ... 38
Harmonics ... 177
Mean (time domain) ... 169
Peak (time domain) ... 169
Percent (OBW) ... 94
RMS (time domain) ... 169
Standard deviation (time domain) ... 169
Time domain ... 169
Power classes
Adding/Removing (SEM) ... 122
Ranges (SEM) ... 122
SEM ... 103, 121
SEM results ... 98
Softkey ... 121
Used (SEM) ... 121
Power mode
Band power measurement ... 376
CP/ACLR ... 57, 67
Softkey ... 57, 67
Power sensors
Activating/Deactivating ... 201
Applications ... 198
Average count ... 204
Configuration (softkey) ... 200
Configuring ... 199
Configuring as trigger ... 207
Connecting ... 199
Continuous Value Update ... 202
Duty cycle ... 204
External power trigger ... 204
External trigger level ... 204
Frequency ... 202
Frequency Coupling ... 203
Measurement time ... 203
Number of readings ... 204
R&S NRP ... 199
R&S Power Viewer ... 199
Reference level ... 203
Reference level offset ... 204
Results ... 199
Selecting ... 202
Setting up ... 205
Settings ... 200
Trigger mode ... 281
Unit/Scale ... 203
Using ... 205
Zeroing ... 202, 206

Power Unit
Softkey 56, 67
Preamplifier
SEM range 115
Setting 252
Softkey 252
Spurious Emissions range 148
Predefined standards
CP/ACLR 53, 63, 86
Presetting
Channels 194
Pretrigger 283
Preview
Trigger/Gate settings 279
Probability range
Statistics 164
Programming examples
ACLR 443
AM Modulatation Depth 520
Frequency sweep 530
MSR ACLR 445
SEM 481
Spurious Emissions measurement 495
Statistics 505
TOI 518
Protection
RF input 195
RF input (remote) 545

Q

Quick Config
Traces 329

R

R&S NRP
Power sensors 199
R&S Power Viewer Plus 199
R&S SMA
External generator 211
R&S SMW
External generator 211
Range 253
Scaling 253
X-axis (statistics) 164
Ranges
Definition (SEM) 102
Deleting (SEM) 118
Deleting (Spurious Emissions) 149
Inserting (SEM) 117
Inserting (Spurious Emissions) 149
Reference (SEM) 102, 119
Remote control (Spurious Emissions) 144
Rules (SEM) 102
Rules (Spurious Emissions) 143
SEM 102
Symmetrical (SEM) 103
RBW
see Resolution Bandwidth 256
Recalling
Calibration settings, external generator 225
Ref Lvl = Mkr Lvl 369
Reference
Fixed 353, 362, 374
Fixed (channel power) 57
Fixed (Delta marker) 379
Marker 362, 374
Phase noise measurement 373
Power (SEM) 120
Range (SEM) 102, 119
Reference channel
CP/ACLR 55, 65
Reference frequency
External generator 211, 221
Reference level 247, 250
Adjusting to transducer factors 294
Auto level 251, 290
CP/ACLR 47
External generator 215
Offset 250
Offset (Power sensor) 204
Position 253
Power sensor 203
SEM range 115
Setting to marker 369
Spurious Emissions range 147
Statistics 164
Unit 250, 251
Value 250
Reference line
External generator 215
Position, external generator 226
Shifting, external generator 216, 226
Value, external generator 226
Reference marker 360
Reference range
Softkey 119
Reference trace
External generator 214, 215
Storing as transducer factor, external generator 215, 226
Reflection measurement
External generator 210
How to, external generator 227
Remote commands
Basics on syntax 397
Boolean values 401
Capitalization 398
Character data 401
Data blocks 401
Numeric values 400
Optional keywords 399
Parameters 399
Strings 401
Suffixes 398
Remote control
Blocked 676
Errors 676
Sequential commands 676
Repeatability
CP/ACLR measurements 42
Repetition interval 282
Resetting
RF input protection 195, 545
Resolution bandwidth
Auto (Softkey) 263
CP/ACLR 45
Harmonics 178
Impact 256
Manual (Softkey) 263
SEM range 114
Spurious Emissions range 147
Statistics 167

Restoring
Channel settings ... 194
Standard files ... 127
Result displays
Diagram ... 302
Marker table ... 302
Peak list ... 303
Result Summary ... 303
Spectrogram ... 303
Result frequency
External generator ... 224
Result Summary
Configuration (SEM) ... 127
Evaluation method ... 303
Result display ... 303
Saving (SEM) ... 128
Results
CP/ACLR measurements ... 38
Data format (remote) ... 614, 615, 616
Exporting ... 331
OBW ... 93
SEM ... 98
SEM (remote) ... 101
Reverse sweep
External generator ... 218, 223
RF attenuation
Auto ... 251
Impact ... 248
Manual ... 251
Mode (SEM range) ... 115
Mode (Spurious Emissions range) ... 148
Noise floor ... 248
SEM range ... 115
Spurious Emissions range ... 148
RF input ... 197
Overload protection ... 195
Overload protection (remote) ... 545
Remote ... 544
RF OVLD
Error ... 675
External generator ... 219
RF OVLD (status display) ... 675
RF Power
Trigger ... 281
Trigger level (remote) ... 592
Rising
Slope (Power sensor) ... 205
RMS
VBW ... 315
RMS detector ... 313
VBW ... 257
RRC filter
SEM ... 120
RUN CONT
Key ... 17, 267, 335
RUN SINGLE
Key ... 17, 267, 268, 335

S

S/N ratio
Measurement example ... 21, 35
Sample detector ... 313
Samples
Statistics ... 161, 169
Saving
Limit lines ... 392
SEM result files ... 132
Settings ... 127
Spurious Emissions result files ... 152
Transducer lines ... 297
Scalar reflection measurement
External generator ... 210
Scaling
Amplitude range, automatically ... 253
Configuration ... 253
Default (statistics) ... 164
Statistics ... 163
X-axis (remote control) ... 574, 611
Y-axis ... 249, 254
Y-axis (remote control) ... 580
Search limits
Activating ... 95, 365
Deactivating ... 95, 366
OBW ... 92, 94
Search Mode
Spectrogram markers ... 366
Search range
Zoom area ... 309
Search Signals
Softkey ... 186, 191
Searching
Configuration ... 363
Configuration (softkey) ... 366
Second harmonic intercept ... 174
Secure user mode
Storage location ... 126
Select Frame
Softkey ... 268, 334
Select Marker ... 361
SEM ... 97
About ... 97
Adding power classes ... 122
Alpha value (RRC filter) ... 121
Applications ... 98
Channel power settings ... 120
Configuring ... 111, 128
Deleting ranges ... 118
Displaying peaks ... 128
Exporting results ... 132
Fast mode ... 106, 114
Filter type ... 114
Format description of export files ... 140
Format description of settings files ... 134
Inserting ranges ... 117
Limit absolute ... 116
Limit check ... 116
Limit lines ... 104
Limit relative ... 116
List evaluation ... 127
List evaluation state ... 128
Measurement ... 15
Measurement result list ... 127
Multiple sub blocks (Multi-SEM) ... 108
Peak margins ... 128
Performing ... 128
Power class ranges ... 122
Power classes ... 103, 121
Preamplifier ... 115
Programming example ... 481
Provided settings files ... 134
Range start/stop ... 113

Ranges ... 102
RBW ... 114
Reference level ... 115
Reference power ... 120
Reference range ... 119
Restoring standard files ... 127
Result files ... 132
Results ... 98
Results (Multi-SEM) ... 100
Results (remote) ... 101
RF attenuation ... 115
RF attenuation mode ... 115
RRC filter ... 120
Saving result summary ... 128
Settings files ... 125, 131
Standard files ... 125
Sweep list ... 112
Sweep points ... 117
Sweep time ... 115
Sweep time mode ... 114
Transducer ... 115
Tx Bandwidth ... 120
Used power classes ... 121
VBW ... 114
Sensitivity
RBW ... 256
Sequencer
Aborting (remote) ... 405
Activating (remote) ... 405
Mode (remote) ... 406
Remote ... 404
Sequential commands
Errors ... 676
Set CP Reference
Softkey ... 57
Settings
File name ... 126
Format description (SEM) ... 134
Provided files (SEM) ... 134
Restoring files ... 127
Storage location ... 126
Settings files
Deleting ... 127
Deleting (SEM) ... 131
Loading ... 126
Loading (SEM) ... 131
Managing (SEM) ... 131
Restoring (SEM) ... 131
Saving ... 127
Saving (SEM) ... 131
Setup files
External generator ... 213, 221, 222
Shift x
Limit lines ... 392
Transducer lines ... 297
Shift y
Limit lines ... 392
Transducer lines ... 297
Shifting
Limit lines ... 384
Short-circuit reflection measurement
Calibration, external generator ... 225
Signal capturing
Duration (remote) ... 586
Signal count
Marker ... 353, 370
Resolution ... 370
Signal counter
Measurement example ... 20
Signal source
Remote ... 544
Signal tracking ... 239
Bandwidth ... 245
Configuring ... 246
Softkey ... 244
State ... 244
Threshold ... 245
Trace ... 245
Single sweep
Softkey ... 17, 267, 335
Single zoom ... 308, 310
Sinusoidal signals
Measurement example ... 18
Slope
Edge gate ... 283
Power sensor trigger ... 205
Trigger ... 283, 592
Trigger (Power sensor) ... 205
SmartGrid
Activating ... 306
Arranging windows ... 307
Display ... 304
Evaluation bar ... 306
Features ... 304
Mode ... 306
Smoothing
Traces ... 319
Traces (group delay) ... 328
softkey
Filter Type (remote control) ... 585
Trace Mode (remote control) ... 507
Softkey
Calibrate Reflection Open (remote control) ... 559
Calibrate Reflection Short (remote control) ... 559
Calibrate Transmission (remote control) ... 559
Normalize (remote control) ... 560
Softkeys
# of Samples (APD, CCDF) ... 161
% Power Bandwidth ... 94
ACLR Mode ... 56, 66
Adjust Settings ... 57, 67, 90, 95, 179
Adjust Settings (APD) ... 161, 165
Adjust X-Axis ... 149
Amplitude Config ... 249
Analysis BW (APD, CCDF) ... 160
Auto All ... 289
Auto Level ... 251, 290
Bandwidth Config ... 261
C/N ... 89
C/No ... 89
Carrier Noise Config ... 89
Center ... 242
Center = Mkr Freq ... 369
Channel Bandwidth ... 90, 95
Clear Spectrogram ... 269, 336
Color Mapping ... 335
Continue Single Sweep ... 17, 268
Continuous Sweep ... 17, 267, 335
Copy Trace ... 337
CP/ACLR Settings ... 52
CP/ACLR Standard ... 53, 63
Display Config ... 301
External ... 280
Frame count ... 269

Free Run ... 280
Frequency Config ... 240
Full Span ... 243
Gated Trigger ... 161
Harmonic RBW Auto ... 178
Harmonic Sweep Time ... 178
History Depth ... 334
Horizontal Line 1/2 ... 386
IF Power ... 280
Input Source Config ... 197
Last Span ... 243
Line Config ... 386, 387
List evaluation ... 127
Lower Level Hysteresis ... 290
Marker 1/2/3 ... 191
Marker 1/2/3/4 ... 186
Marker Config ... 359, 361
Marker Search Area ... 367
Marker Search Type ... 367
Marker to Trace ... 361
Meastime Auto ... 290
Meastime Manual ... 290
Min ... 368
MSR Configuration ... 122
Next Min ... 368
Next Mode X ... 366
Next Mode Y ... 367
Next Peak ... 368
No. of Harmonics ... 178
Noise cancellation ... 56, 66, 252
Norm/Delta ... 360, 371
Outputs Config ... 234
Peak ... 368
Percent Marker ... 160
Power classes ... 121
Power Mode ... 57, 67
Power Sensor ... 281
Power Sensor Config ... 200
Power Unit ... 56, 67
Preamp ... 252
Ref Level ... 250
Ref Level (APD; CCDF) ... 164
Ref Level Offset ... 250
Reference range ... 119
Res BW Auto ... 263
Res BW Auto (remote) ... 581
Res BW Manual ... 263
RF Atten Auto ... 251
RF Atten Manual ... 251
RF Power ... 281
Scale Config ... 253
Search Config ... 363, 366
Search Signals ... 186, 191
Select Frame ... 268, 334
Select Marker ... 361
Set CP Reference ... 57
Signal Track ... 244
Single Sweep ... 17, 267, 335
Span Manual ... 242
Spectrogram ... 334
Standard files ... 125
Start ... 242
Stop ... 242
Sweep Config ... 261
Sweep count ... 265
Sweep list ... 112
Sweep Time ... 58
Sweeptime Auto ... 263
Sweeptime Manual ... 263
Time ... 282
Timestamp ... 335
Trace 1/2/3/4 ... 330
Trace Config ... 326, 332
Transducer ... 292
Trigger Offset ... 282
Trigger/Gate Config ... 277
Upper Level Hysteresis ... 290
Vertical Line 1/2 ... 386
Video ... 280
Video BW Auto ... 263
Video BW Manual ... 263
Zero Span ... 243
Sort mode
Peak list ... 377
Source offset
External generator ... 223
Source power
External generator ... 223
Spacing
MSR, adjacent channels ... 72
MSR, gap channels ... 75
Spacings
CP/ACLR ... 59
Span ... 242
Band power measurement ... 376
Carrier-to-Noise ... 88
CP/ACLR ... 44
Manual ... 242
Span/RBW coupling ... 257
Spectrograms
Activating/Deactivating ... 334
Clearing ... 269, 336
Color curve ... 324, 337, 342
Color mapping ... 323, 335, 336, 341
Color scheme ... 323, 337
Configuring ... 340
Continue frame ... 322
Display ... 320
Displaying ... 339, 340
Evaluation method ... 303
Frame count ... 322
History depth ... 334
Markers ... 325, 340
Removing ... 340
Scaling ... 322
Selecting frames ... 268, 334
Settings ... 333
Softkey ... 334
Sweep count ... 322
Time frames ... 321
Timestamps ... 322, 335
Value range ... 324, 341
Spectrum Emission Mask
see SEM ... 97
Spurious Emissions ... 141
About ... 141
Configuring ... 145
Deleting ranges ... 149
Detector ... 147
Displaying peaks ... 150
Evaluation list ... 142
Exporting results ... 152
Filter type ... 146
Format description of export files ... 152

Inserting ranges ... 149
Limit absolute ... 149
Limit check ... 149
Limit lines ... 144
List details ... 150
List evaluation ... 149
List evaluation state ... 150
Measurement ... 15
Measurement result list ... 149
Peak margins ... 150
Peaks ... 142
Peaks per range ... 151
Performing ... 145, 151
Preamplifier ... 148
Programming example ... 495
Range start/stop ... 146
Ranges ... 143
RBW ... 147
Reference level ... 147
Result files ... 152
Results ... 142
RF attenuation ... 148
RF attenuation mode ... 148
Saving list evaluation ... 151
Sweep behavior ... 148
Sweep list ... 145
Sweep points ... 148
Sweep time ... 147
Sweep time mode ... 147
Transducer ... 148
VBW ... 147
Standard
MSR Tx channel ... 70
Standard deviation
Power (time domain) ... 169
Standard files
Multi-SEM ... 125
Softkey ... 125
Standards
CP/ACLR measurements ... 53, 63
Format description (SEM) ... 134
Provided files (SEM) ... 134
Restoring files (SEM) ... 127
Settings files (Multi-SEM) ... 119
Settings files (SEM) ... 125
Start frequency
Softkey ... 242
Statistics
Default scaling ... 164
Gated trigger ... 158
Measurements ... 154
Optimizing ... 169
Programming example ... 505
Scaling ... 163
see also APD, CCDF ... 154
Status bar
Color coding ... 674
Error messages ... 674
Error messages, external generator ... 219
Status registers
STAT:QUES:POW ... 545
Step size
Markers ... 362
Stop frequency
Softkey ... 242
Storage location
Secure user mode ... 126
Settings ... 126
Sub blocks
Configuring ... 69
MSR, Center frequency ... 69
MSR, number of Tx channels ... 69
MSR, RF bandwidth ... 69
MSR, Tx channel definition ... 69
Number (Multi-SEM) ... 119
Standard files ... 125
Suffixes
Remote commands ... 398
Support ... 679
Sweep
Aborting ... 267, 268, 335
Behavior (Spurious Emissions) ... 148
Configuration (Softkey) ... 261
Continuous ... 17
Count ... 260, 265
Count (Spectrograms) ... 322
Default settings ... 255
Mode ... 17, 260
Performing ... 17
Points ... 260, 265
Points (SEM range) ... 117
Points (Spurious Emissions range) ... 148
Settings (Spectrogram) ... 268
Single ... 17
Time (remote) ... 586, 588
Type ... 258, 266
Type (remote) ... 588
Sweep list
Deleting ranges ... 118, 149
Detector ... 147
Fast SEM ... 114
Filter type ... 114, 146
Inserting ranges ... 117, 149
Limit absolute ... 116, 149
Limit check ... 116, 149
Limit relative ... 116
Preamplifier ... 115, 148
Range start/stop (SEM) ... 113
Range start/stop (Spurious Emissions) ... 146
RBW ... 114, 147
Reference level ... 115, 147
RF attenuation ... 115, 148
RF attenuation mode ... 115, 148
SEM ... 112
Softkey ... 112
Spurious Emissions ... 145
Sweep behavior ... 148
Sweep points ... 148
Sweep points (SEM) ... 117
Sweep time ... 115, 147
Sweep time mode ... 114, 147
Symmetrical ... 118
Transducer ... 115, 148
VBW ... 114, 147
Sweep points
Logarithmic x-axis scaling ... 239
Sweep time ... 259
Auto (Softkey) ... 263
CP/ACLR ... 44, 58
Harmonics ... 178
Manual (Softkey) ... 263
SEM range ... 115

Softkey 58
Spurious Emissions range 147
Statistics 161
Values 263
Sweep time mode
SEM range 114
Spurious Emissions range 147
Sweeps
Reverse, external generator 218
Symmetric setup
SEM 118
SEM ranges 103

T

Tabs
MultiView 11
TCP/IP
Address, External generator 221
External generator 221
Technology
MSR Tx channel 70
Third order intercept point
see TOI 179
Threshold
Limit lines 384, 391
Peak search 365
Signal tracking 245
Time Domain Power 169
About 169
Configuring 171
Limit lines 170, 171, 172
Measurement 16
Measurement example 172
Measuring 172
Restricting range 170
Results 169, 171
Time frames
Configuring 268
Continuing 268
Navigating 268, 323
per sweep 269
Selecting 268, 334
Spectrograms 321
Time trigger
Repetition interval 282
Softkey 282
Timestamps
Softkey (Spectrogram) 335
Spectrograms 322, 335
TOI 179
About the measurement 180
Basics 180
Calculation method 182
Configuring 185
Determining 186
Markers 186
Measurement 16
Programming example 518
Results 184
Search signals 186, 187
Total Harmonic Distortion
Measurement 177
Trace math 319
Functions 332
Settings 332
Trace smoothing 319
Traces 330
Average mode 329
Averaging 318
Averaging (algorithm) 317
Averaging (remote control) 584
Combining results 319
Configuration 326
Configuration (Softkey) 332
Configuring 337
Copying 337
Copying (remote control) 612
Detector 313, 328
Detector (remote control) 608
Export format 331
Exporting 330, 331, 338
Hold 328
Mode 327
Mode (CP/ACLR) 47
Mode (remote) 609
Settings, predefined 329
Traces to be Checked
Limit lines 388
Tracking
see External generator 222
Tracking bandwidth 245
Tracking generator
see External generator 207
Tracking threshold 245
Transducers
Activating/Deactivating 294
Adjusting reference level 294
Calibration with external generator 215, 226
Checking 298
Comment 296
Compatibility 294
Compatible 298
Configuration 291
Configuring 297
Copying 295, 299
Creating 295, 299
Data points 297
Deleting 295, 299
Deleting values 297
Editing 295, 298
Factors 291
Inserting values 297
Managing 293
Name 296
Saving 297
SEM range 115
Settings 292
Shifting 297, 300
Softkey 292
Spurious Emissions range 148
Storing 292
Unit 296
Validity 292
View filter 294
X-axis 297
Y-axis unit 291
Transmission measurement
Calibration, external generator 224
External generator 210
How to, external generator 227
Trigger
Configuration preview 279
Drop-out time 282

Drop-Out Time ... 273
Drop-out time (Power sensor) ... 205
External (remote) ... 592
External power ... 204
External, errors ... 676
Holdoff ... 274, 283
Holdoff (Power sensor) ... 205
Hysteresis ... 272, 283
Hysteresis (Power sensor) ... 205
Level (Power sensor) ... 204
Measurements ... 271
Offset ... 272, 282
Output ... 236, 283
Power sensor ... 204, 207
Slope ... 283, 592
Slope (Power sensor) ... 205
Trigger level ... 282
External trigger (remote) ... 591
I/Q Power (remote) ... 591
IF Power (remote) ... 591
RF Power (remote) ... 592
Trigger source ... 272, 279
External ... 280
Free Run ... 280
IF Power ... 280
Power Sensor ... 281
RF Power ... 281
Time ... 282
Video ... 280
Trigger/Gate
Configuration (Softkey) ... 277
Troubleshooting
CP/ACLR ... 85
Input overload ... 545
Low frequencies ... 679
Overload, external generator ... 220
Remote control programs ... 677
see User Manual ... 674
Timeout for data capture ... 679
Trace display ... 679
TTL handshake
see TTL synchronization ... 221
TTL synchronization
AUX control, external generator ... 208
External generator ... 208, 217, 221
Tx bandwidth
SEM ... 120
Tx channel
MSR, Center frequency ... 70
MSR, technology ... 70
Tx channels
in MSR sub blocks ... 69
MSR, configuring ... 69
MSR, weighting filters ... 71

U

UNCAL
Error ... 675
UNCAL (status display) ... 675
Units
Power sensor ... 203
Reference level ... 250, 251
Transducer factors ... 296
Y-axis (statistics) ... 164
Upper Level Hysteresis ... 290
User ports
Remote control ... 568
User standards
CP/ACLR ... 53, 64
Loading (CP/ACLR) ... 80
Managing ... 53, 64
Storing (CP/ACLR) ... 80

V

VBW
CP/ACLR ... 46
RMS detector ... 315
see Video bandwidth ... 256
SEM range ... 114
Spurious Emissions range ... 147
VBW/RBW coupling ... 257
Vertical Line 1/2
Softkeys ... 386
Video
Output ... 196
Trigger source ... 280
Video bandwidth ... 263
Auto (Softkey) ... 263
Impact ... 256
Manual (Softkey) ... 263
RMS detector ... 257
Video output ... 235, 566
View filter
Limit lines ... 388
Transducer lines ... 294
Visible
Limit lines ... 388

W

Weighting filters
CP/ACLR ... 61
MSR ACLR ... 71
MSR, adjacent channels ... 73
MSR, gap channels ... 76
Remote ... 418
White noise
Measurement example (statistics) ... 167
Windows
Adding ... 306
Adding (remote) ... 537
Arranging ... 307
Closing ... 307
Closing (remote) ... 539, 542
Layout (remote) ... 540
Maximizing (remote) ... 536
Querying (remote) ... 538, 539
Replacing (remote) ... 540
Splitting (remote) ... 536
Types (remote) ... 537
WRONG_FW
Error ... 675

X

X-axis
Adjusting (Spurious Emissions) ... 149
Limit lines ... 391
Scaling ... 239, 242
Transducer lines ... 297

X-Offset
Limit lines 389
X-value
Marker 359

Y

Y-axis
Limit lines 391
Max/Min (statistics) 164
Optimizing display 254
Scaling 249, 254
Settings 253
Y-Offset
Limit lines 389
YIG-preselector
Activating/Deactivating 198
Activating/Deactivating (remote) 546

Z

Zero span
Measurement 13
Measurement examples 31
Softkey 243
Zeroing
Power sensor 202
Zoom limits
Search range 309
Using for searches 366
Zooming 308, 311
Activating (remote) 604
Area (Multiple mode, remote) 603
Area (remote) 603
Deactivating 310
Multiple mode 308, 310
Multiple mode (remote) 604
Restoring original display 310
Single mode 308, 310